Sustainable open space planning and implementation with an assessment of the applicability of GIS in local communities

by

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Dedicated to the honor and remembrance of my Grandfather,

William Wightman Winkler

(1915 - 2001)

whose lifetime achievements and motivations served as an example, and

whose generosity and love made this degree and my education possible

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ABSTRACT

This research creates a conceptual open space planning process model and a demonstration model that uses GIS (Geographic Information System) software as a means to determine solutions. The conceptual open space planning process model integrated 1) citizen participation and intergovernmental staff cooperation, 2) planning concepts, and 3) sustainability principles. The demonstration model displayed GIS applications through the use of ArcView GIS 3.2 and Spatial Analyst's ModelBuilder extension. Methods pertaining to GIS as a planning tool aid a community in decision-making as part of the planning process for the efficient implementation of a sustainable open space.

As communities continue to urbanize, there is an increasing need and demand for public open space. An open space was defined as containing environmentally sensitive land, and providing social and recreational aspects for the enjoyment of local citizen populations. Sustainability principles, as related to open spaces, are comprised of three interrelated pillar values: social, economic, and environmental. Community developments in the form of sustainable open spaces meet the social demands and desires of local citizens, while also benefiting a community economically and promoting natural progression environmentally.

The resulting models produced in the report are substantiated and related back to techniques and applications for the implementation of sustainable open spaces in local communities. It was recommended that decision-makers, planners, community stakeholders, and the general public work together to explore the options of acquiring, establishing, funding, and protecting a sustainable open space once its location has been determined. The end-results of this investigation aid as a planning resource for citizens and planners looking for options and recommendations to implement, preserve, and protect, sustainable open spaces within their local communities.

CHAPTER 1. INTRODUCTION

This thesis presents a conceptual open space planning process model that integrates citizen participation and intergovernmental cooperation with sustainability principles. Additionally, this thesis portrays a demonstration model exhibiting the applicability of Geographic Information Systems (GIS) as a planning tool and as a means to determine solutions. The purpose of this thesis was to serve as a reference of how to plan and implement a sustainable open space within a community. The thesis project sought to provide a workable method allowing local communities the opportunity to participate in a community-based, technology-linked land use decision-making approach. Project goals included the following:

- To conceptualize an open space planning process allowing for the implementation of sustainable open spaces in local communities; and,
- To apply and present GIS as a planning tool, and as a means to determine solutions for decision-making and implementation strategy, using a demonstration model and following techniques drawn out in the conceptual open space planning process.

In this thesis, GIS was used as a tool and strategy for implementation to approach the question of how a sustainable open space may be efficiently established in a community. To answer this question, a conceptualized open space planning process model and a demonstration model using GIS that involved a community in a hypothetical situation was created. In the demonstration model, ArcView GIS 3.2 and Spatial Analyst's ModelBuilder extension were used as a means to determine where to site a sustainable open space based upon natural resource factor's datasets and hypothetical criteria. The use of GIS as a planning tool in decision-making was shown to be a smart growth approach towards sustainable land-use management of environmentally sensitive areas within a community.

This thesis provided an investigation that included an exploration of ideas, recommendations, concepts, and analysis of open space. The objectives of the investigation were the following:

1. Define "open space" and "sustainability" in relation to the preservation of environmentally sensitive areas in an urbanized area;
2. Relate sustainability and its three pillars (social value, environmental value, economic value) to the purpose and implementation of preserving or setting aside environmentally sensitive open spaces in urbanized areas;
3. Develop a conceptual open space planning process model that incorporated GIS, as a planning tool and as part of the planning process, while strategizing for the creation of sustainable open spaces in urban developments;
4. Provide justification for the methodological prioritization and selection of natural resource factors in order to distinguish and form criteria regarding what an environmentally sensitive area ought to represent in a community; and,
5. Create a viable demonstration model that displays a "walk-through" of a sustainable open space suitability analysis process. This model was to be created using the software technology of ArcView GIS 3.2 and Spatial Analyst's ModelBuilder extension application, and through the presentation of a hypothetical situation involving the geographic location of Story County, Iowa (specifically focusing on the City of Ames).

<u>Propositions</u>

The first proposition was that the creation of a conceptual open space planning process model, through its description and explanation of phases, would demonstrate methods and an efficient process for the preservation and/or implementation of sustainable open spaces.

The second proposition was that the appropriate use of GIS as a planning tool within the conceptual open space planning process model, would prove to be a viable means to determine solutions and aid in decision-making about open spaces.

The third proposition was that this analysis and demonstration of the open space planning process could be applied to the efficient establishment of sustainable open spaces in local communities.

The end goal of addressing the propositions was that the structure and content of this thesis, with its presentation and explanation of models, would aid as a planning resource reference for those readers wishing to implement, preserve, and protect, sustainable open spaces in their local communities.

Background/Setting

The issue of urban sprawl has mushroomed in the United States as land-use has been increasingly altered and transformed into residential suburbanized areas. This ongoing decentralization of urban land-uses (or "sprawl") and associated economic and social functions have dramatically altered how Americans live, work, recreate, use energy, and impact the environment. "Sprawl" is characterized as being "a suburban phenomenon – 'beyond a city's limits,' 'transitional,' or 'on the urban fringe'; it is also generally typified as being low density, favoring automobiles, and possibly 'scattered,' 'unplanned,' or 'ad hoc' in its pattern" (Gillham 2002, 3). Sprawl is a problem that must be solved for the sake of future communities and to better manage and preserve land. Land areas deemed as environmentally sensitive are threatened by sprawl (Fodor 1999):

> [Growth caused by urbanization] permanently destroys many of the productive values of natural land: food production potential; outdoor recreation opportunities; open space; fresh air; quiet and serenity; beautiful views; watershed quality (water purification, groundwater recharging, and flood control); wildlife habitat; species diversity; and ecosystem functions (Fodor 1999, 18 & 20).

Once land areas are developed, the preservation of environmentally sensitive areas is often threatened (Benhart and Welsh 1992). As communities continue to urbanize, there is an increasing need for smart land-use approaches of environmentally sensitive land. Open spaces that are "sustainable" within urbanized community developments encompass and address a combination of three pillars: social values, market values, and environmental values (Kaiser, Godschalk, and Chapin, Jr. 1995). These three pillar values are interrelated and need to be evaluated as a whole in order to create a successful land-use plan designating and preserving open spaces.

To provide for the better management of land-use within communities, "smart growth" approaches are being increasingly created and adopted. Smart growth reduces the share of growth occurring on newly urbanizing land, existing farmlands, and in environmentally sensitive areas (American Planning Association 2002). Essentially, smart growth is a responsible, long-term growth management approach that focuses on *how* growth occurs (Fodor 1999). Smart growth approaches in planning allow for the following: guides, develops, revitalizes and builds communities that have a unique sense of community and place; preserves and enhances valuable natural and cultural resources; and, values long-range considerations of sustainability (American Planning Association 2002).

A smart land-use approach is the implementation of sustainable open spaces in growing communities. Open spaces that are sustainable have been shown to be important land-use assets in a community. These spaces meet the social demands and desires of local citizens while increasing a community's economic value. Open spaces that are sustainable play an important role in the future of neighborhood societies in terms of allocating space, preserving nature, and accommodating change in the spatial environment with changes in the social environment. Moreover, sustainable open spaces provide land-use design approaches of smart growth that connect together people, parks, historic sites, and natural areas.

Thesis Organization

The thesis is presented in five chapters. In Chapter 2, *Literature Review*, terms are defined in detail for the reader. These terms are then related to each topic and subject area in the context of sustainable open spaces. The literature review defined the major concepts necessary to understand the history, description, evaluation, and significance of open space. In this chapter, open spaces were first defined in the context of planning and then related the purposes of open space preservation to the principles of sustainability.

In the third chapter, participatory roles in the planning process are identified. The identification of these participatory roles involved the cooperation of local citizens, planners, and intergovernmental staff. The role of the comprehensive plan in the planning process is also discussed in this chapter, along with a needs assessment and data collection discussion. Planning process models from planning literature are reviewed in Chapter Three; based upon the review of these models, a conceptual open space planning process model was created for the purpose of providing direction to local communities wishing to establish a sustainable open space. Then, a selection and justification of natural resource factors as input and/or data are described and related to this created model.

Also in Chapter Three, methods were presented using GIS as a planning tool to approach how to geographically select open spaces in the urban pattern based upon a community's selection of factors and criteria. A GIS is a computer-based tool for mapping and analyzing things that exist and events that happen on Earth (Anderson 2002). This tool may be used to explain events, predict outcomes, and plan strategies (Land Information and Computer Graphics Facility 2002). GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps (Environmental Systems Research Institute, Inc. 1998). GIS, as used in this thesis, helps improve the availability and quality of information to aid a community in making more informed decisions.

In Chapter Four, a demonstration model was used as a “walk-through” example displaying the suitability analysis of a community's hypothetical open space criteria through a ranking and weighting method. Through mapping effects using GIS applications, the demonstration model displays the value and importance of land-use maps as visual aids influencing the establishment, preservation, and conservation of sustainable lands for the benefit of the public good. The demonstration model distinguishes GIS as a planning tool and recognizes that its use in the planning process may aid in selecting beneficial land to preserve. Chapter 4, *Results*, also included an introspective glance at what other existing software technologies (outside of GIS) may be beneficial as planning tools and as a means to determine solutions in the planning process.

Chapter 5, *Implementation*, offers document language techniques and funding recommendations that may be used to preserve and protect open spaces. Applications that a community may use as implementation strategies towards the incorporation of a sustainable open space are also summarized.

The final chapter, Chapter Six, analyzes the conceptual open space planning process and demonstration models in reference to open space and in relation to sustainability principles. Recommendations for future study and additional research are made in this chapter.

Importance of the Study

This thesis serves as a resource and a reference for planners and communities wanting to create sustainable open space areas within their communities. This thesis informs readers of the social values, environmental values, and economic values involved in the conservation and preservation of natural resources and environmentally sensitive areas. The use of GIS in the planning process creates a thoughtful approach to land-use management planning and designing with nature. Moreover, the incorporation of this approach into future land-use designs and land-use policy plans allocates those lands potentially threatened by growth and/or sprawl to be better planned and managed. In addition to the use of GIS as a planning tool, this thesis describes concepts and methods that may be effectively used to implement a sustainable open space within a community.

CHAPTER 2. LITERATURE REVIEW

This literature review includes discussion regarding the major concepts necessary to understand the evaluation, description, conception, and significance of open space. Open spaces are defined in the context of planning and the purpose of open space preservation was related to sustainability principles.

As a whole, this chapter provides detailed definitions for the reader and relates each topic and subject area in context to sustainable open spaces and the planning process.

Open Spaces Defined and in Context to Planning

For the purpose of this thesis, an open space is defined as land contained within metropolitan areas surrounding and protecting vital natural processes and/or environmentally sensitive areas, and which provides for aesthetic, social, and recreational purposes within the lives of people. Many different and diverse definitions of open space exist. An understanding of open space varies by history and purpose.

The phrase "open space" is commonly used more and more in present-day society. The City Beautiful movement, personified by landscape architect Frederick Law Olmsted from the year 1900 to about 1910, forecasted the phrasing and terminology of open space. Olmsted's City Beautiful movement aided in the "growing sponsorship of municipal art in major U.S. cities, a widespread grass roots interest in civic improvement, and outdoor art and recreational space" (Alexander 1992, 23). Moreover, "the City Beautiful movement was a political movement, for it demanded a reorientation of public thought and action toward urban beauty" (Wilson 1989, i). During the time of the City Beautiful movement, middle and upper-middle-class Americans attempted to re-establish their cities into beautiful, functional bodies (Wilson 1989). Physical urban design mixed aesthetics and environmentalism to create beautiful surroundings, which in turn enhanced worker productivity and urban economics (Wilson 1989). Olmsted's supporting argument for the movement was that through the creation of parks, aesthetic improvements "raised surrounding land values, contributed to private enterprise and returned the [original costs of funding the park] through increased municipal real estate taxation" (Wilson 1989, 10).

Through direct involvement of citizen activism within community design, the City Beautiful movement was an important source of urban planning. "The movement's concerns for converting ugliness to beauty and for controlling and enhancing economic and physical growth were compelling… Equally powerful was the movement's desire for comprehensiveness, utility, and functionalism" (Wilson 1989, 4). More importantly, parks created during the movement were acknowledged as valuable commodities of nature within the lives of people from all social classes by serving as city escapes and areas of recreation.

Toward the end of the nineteenth century, and following in the footsteps of Olmsted's visionary civic beauty ideology, a movement formed in Britain involving "garden cities". Ebenezer Howard proposed "garden cities", planned settlements that would combine industry and agriculture into a distinct unit (Baylor 1975). Howard's garden cities exhibited one of the most comprehensive attempts to design a sustainable urban settlement (Devuyst 2001). Limits on growth were included in these settlements through the existence of surrounding greenbelts, "so that success could not cause ugly expansion" (Baylor 1975, 4). The settlements were to create efficient, healthy, working communities in which limited populations existed, the land was publicly owned, and private enterprise thrived (Baylor 1975).

The Garden City movement and its foundation principles had a worldwide influence on planning and urban settlements. Through the inclusion of social and economic factors, in planning, the Garden City movement hinted in large part towards what was to become the concept of comprehensive planning (Alexander 1992).

About the same time as the Garden City movement was popularized, Patrick Geddes proposed regional planning. Geddes, a Scottish biologist-turned-planner, proposed "the 'natural region' or the City-Region as the appropriate unit for analyzing the physical and human environment" (Alexander 1992, 27).

Decades later, landscape architect and ecological planner Ian McHarg developed and advocated Geddes' regional planning ideas, treating the physical and human environment as a unit. Through McHarg's concept of designing with nature, he advocated a human cooperation with the environment and its biology. McHarg, similar to the City Beautiful movement, worked with the ideas of physical urban design and concepts involving aesthetics and the environment. Faced with growing societies and limited space, McHarg did not so much attempt to halt development but rather to design with it. Asked some years ago to advise on which lands in the Philadelphia metropolitan region should be selected for open space, McHarg responded that it had become clear to him at the onset that the solution "could only be obscured by limiting open space to the arena for organized sweating," and that, "it seemed more productive to consider the place of nature in the metropolis" (McHarg 1992, 55). McHarg (1992) maintained the principle that natural processes within metropolitan areas should be protected within open spaces:

> There is a need for simple regulations, which ensure that society protects the values of natural processes and is itself protected. Conceivably such lands wherein exist these intrinsic values and constraints would provide the source of open space for metropolitan areas. If so, they would satisfy a double purpose: ensuring the operation of vital natural processes and employing lands unsuited to development in ways that would leave them unharmed by these often violent processes. Presumably, too, development would occur in areas that were intrinsically suitable, where dangers were absent and natural processes unharmed (McHarg 1992, 55-6).

For the purpose of this thesis, McHarg's vision of open space within metropolitan areas is supported and emphasized. Open spaces are those lands of vital natural processes or environmentally sensitive areas (and which are therefore unsuited for development). McHarg (1992) planned with urbanization and nature in order to implement open space:

> Urbanization proceeds by increasing the density within and extending the periphery, always at the expense of open space. As a result – unlike other facilities – open space is most abundant where people are scarcest. This growth, we have seen, is totally unresponsive to natural processes and their values. Optimally, one would wish for two systems within the metropolitan region – one the pattern of natural processes preserved in open space, the other the pattern of urban development. If these were interfused, one could satisfy the provision of open space for the population (McHarg 1992, 57).

The background and understanding of planning history and the element of nature is important to the formation of the definitions and interpretations of open space.

In more recent times, the existing Subcommittee on Open Space from Boston's parks department posed the question "what is open space?". Multiple answers came back amounting to a response that further supported confusion when it comes to defining the term "open space" (Kay 2001). Answers to the posed question included the following: "Open to the sky; accessible to the public...you know it when you see it; hard vs. soft...includes paved surfaces, green surfaces including grass, trees, bushes, and flower beds, water surfaces including ice and edging; active vs. passive and both; structure vs. non-structure and both with the buildings subservient" (Kay 2001). While these definitions seek abstract descriptions and details of what open spaces may contain and encompass, the very purpose and value of open space is left unjustified. Open space is the preservation of remaining natural areas that are threatened by growth and the forces of urbanization (Kay 2001). The sub-committee's definitions recognized that the form and purpose of open space lands reflect the diversity of groups forming the "open space movement" (Kay 2001).

More so, these "groups" ought to have a commonality in purpose for forming such an "open space movement," such as citizens' growing recreation needs, the preservation of scenic and historic resources, conserving threatened land and water resources, and providing relief from urban congestion.

"'Open land' can, of course, include many things, playgrounds and wilderness areas, public parks and sanctuaries where only scientists are welcome" (Brenneman 1967, viii). Moreover, "to some people open space means green space which has been saved in and around cities – parks, golf courses, wildlife sanctuaries. To others it connotes vacant land not yet committed to development but capable of being built upon. To still others, reservoirs, lakes, rivers, parkways, air space, and just about everything not covered by concrete, steel or asphalt represent open space" (Shomon 1971, 12). "Open space and urban open land – land set aside for non-development – are not synonymous" (Shomon 1971, 12).

In this thesis, open space refers to "lands intended to conserve and protect valuable natural features and processes" (Kaiser, Godschalk, and Chapin, Jr. 1995, 295). Natural features and their processes perform useful functions for both nature and humanity and should therefore be allocated appropriate space in a community's plans to be protected through land use management measures (Kaiser, Godschalk, and Chapin, Jr. 1995). For this thesis, "open space" is land contained within metropolitan areas surrounding and protecting vital natural processes and/or environmentally sensitive areas, and which provides for aesthetic, social, and recreational purposes within the lives of people. Sustainable open spaces include environmentally sensitive natural areas and allow people and habitat to co-exist.

Sustainability

The goal of developing sustainably is to develop without causing critical environmental damage, while meeting the economic and social needs of present and future generations (Kaiser, Godschalk, and Chapin, Jr. 1995). Sustainability principles may be used to justify and prioritize the establishment of an open space. Sustainability is frequently associated with quality of life planning and design issues, regularly related to forms of development seeking better integration of land use planning.

In the context of this thesis, sustainability specifically deals with sustainable urban development. Sustainable development is a concept linking environmental, economic, and social use values (Kaiser, Godschalk, and Chapin, Jr. 1995). An analysis of sustainable development, "looks at the feasibility of environmental management strategies in light of related economic and social needs rather than in isolation; it recognizes the need to conserve natural (ecological) capital and to develop human capital through wise use of economic capital" (Kaiser, Godschalk, and Chapin, Jr. 1995, 50).

Sustainability, as a practice and a method offers a model to manage land-use change and/or the incorporation of an open space within a community. Kaiser, Godschalk, and Chapin, Jr. (1995) offer a structural analogy to better comprehend land use change management and its involvement within the practice of sustainable development. This model can be "visualized as the seat or main integrating framework of a stool whose three legs are social use, market, and ecological values. Further joining the legs is the overarching concept of sustainable development" (Kaiser, Godschalk, and Chapin, Jr. 1995, 52; see Figure 1, page 14). "For the stool to stand, every part must be in place, equally proportioned and properly joined" (Kaiser, Godschalk, and Chapin, Jr. 1995, 52).

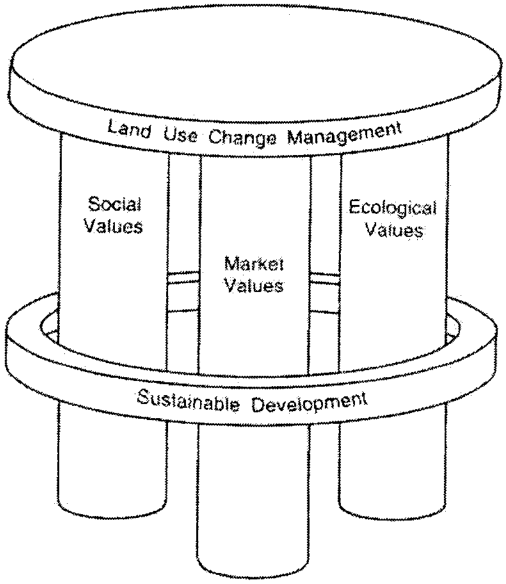

Figure 1. Land-Use Change Management as a Three-Legged Stool
(Source: Kaiser, Godschalk, and Chapin, Jr. 1995, 52)

> Each leg [in the model] – or value – is necessary; if social values, as exemplified by neighborhoods and activity patterns, are not accounted for, then citizens will not accept planning" (Kaiser, Godschalk, and Chapin, Jr. 1995, 52). Likewise, "if market/[economic] values, as exemplified by profit-seeking real estate development, are not accounted for, then city building cannot take place; If ecological/[environmental] values, as exemplified by natural resource conservation, are not accounted for, then development cannot be sustained (Kaiser, Godschalk, and Chapin, Jr. 1995, 52).

Sustainability principles and/or the pillars shown in Figure 1, connect and link together social, market, and environmental values.

Social value of sustainability

In order for an open space to meet the social value of sustainability, a site needs to be accessible by not only meeting citizen's demands and enhancing their quality of life (by being a place that they will enjoy congregating in, recreating in, etc.), but also by being accessible to community members. Open space that is determined to be un-accessible, due to location, size (carrying capacity), safety, or otherwise, can be considered un-equitable as it fails to allow fair and equal access to all citizens in a community.

Equity of access could relate to how landowners choose to contribute their land (privately or publicly) and/or if the government chooses to burden community residents with user fees or taxes incorporated from sustainable open space land-uses. When an open space is considered un-equitable, it does not allow citizens to participate and interact. An un-equitable open space might consider a community liable for not planning better, and thus not producing an equally accessible "commons". However unintentional it may be, this is effectively discriminatory against a portion of the population, which then can become a matter of justice. Sense of place and the quality of life as formed and designed in a community play profound roles in citizen's perceptions of the areas they live in; an open space that denies anyone of this right is not sustainable. Measuring a community's quality of life, "extends into qualitative values such as [citizens] having a sense of belonging to a community, feeling safe enough to play outdoors, and having a close connection to nature even in the most populated neighborhoods and largest cities" (Devuyst 2001, 292).

Sustainable open spaces socially provide for recreational needs, provide for mental and physical human release from denser areas (thus aiding in the development of healthy personalities), as well providing for naturally attractive areas within a community. Geographer Yi-Fu Tuan (1974) coined the term "topophilia," or what he referred to as "the effective bond between people and place or setting" or the "human love of place" (Thayer 1994). Robert Thayer (1994, 4-5) employs the term topophilia to designate "the range of positive human emotions relating to affection for land, earth, and nature." Thayer (1994) investigates the effect of open space on humans and their viewed quality of life:

> The most publicly recognizable side of topophilia is likely to be the aesthetic experience in natural surroundings...Scant attention has been paid, however, to understand why this is so – how the actual, human experience of

> pleasurable response to the land operates...Many different themes emerged which characterized the experiences...Most reported that their experiences took place outside during day-light, dawn, or dusk hours, involved 'nature' or natural features, and that their moods improved after the event. A great many felt that the aesthetic experience was as good or better than any other positive experience they had during the week (Thayer 1994, 7-8).

Sustainable open spaces, when established within a community, provide spaces within busy urban settings that allow for one to "get away from it all", enjoy nature, get a breath of fresh air, and socialize with their neighbors in aesthetically pleasing, natural settings.

Environmental value of sustainability

The establishment of sustainable open spaces in a community allows for human development and nature to co-exist. The preservation of sustainable open space takes advantage of natural resource features and environmentally sensitive areas (such as forests, woodlands, wetlands, and water sources) as development occurs and communities continue to grow. Open space areas "satisfy a double purpose: ensuring the operation of vital natural processes and employing lands unsuited to development in ways that would leave them unharmed" (McHarg 1992, 55-56).

Environmental aspects, as reflected and included in the form of sustainable open spaces not only allow for conservation practices, but also provide the general public with places of mental escape, relaxation, and recreation. The need to protect environmental resources, such as land and water in urban areas for conservation purposes, has grown as a concept with the public and within individual communities. The destruction or lack of open land not only significantly adds to flooding and pollution within communities, but results in the loss of lands that have intrinsic values as well (Department of Housing and Urban Development, 1965).

Essentially, the environmental value of sustainability largely incorporates land-use planning. "New and perhaps radical approaches to land-use planning are required for dealing with the pervasive environmental problems we face today and must continue to face in the future" (McAllister 1973, 11). "It is being increasingly recognized that more effective land-use planning and control are the key to environmental protection and enhancement" (McAllister 1973, 11). Open spaces that are connected, adjacent to, or surrounding environmentally sensitive areas provide a key amenity resource within a community. Open spaces allow people to exist with nature without displacing nature and its habitat, and they allow people to live and develop while not harming the natural order of processes provided by Mother Earth.

Landscape ecology tied to sustainability

Landscape ecology principles offer the prospects of conservation design in communities and how to best establish a sustainable open space in the urban pattern while maintaining environmental processes and keeping order with nature. Landscape ecology principles have the ability to effectively aid in site planning by providing in maintaining and restoring ecological processes and in maintaining the health of a landscape: Patches appear scattered and exhibit degrees of isolation in terms of plant and animal habitat; edges are defined as outer portions of patches differing from the interior of the patch; corridors provide for landscape connectivity, allowing such things as wildlife movement – greenways, streams, and rivers are examples of corridors; and, land mosaics are types of "networks", facilitating or inhibiting flows and movements (Labaree 1992). These concepts become very important when measuring the ecological impacts of development.

The principles of landscape ecology specifically involve planning with the environment in mind; some may even say that it is the process of designing with nature. "Landscape ecology can be considered the study of the interferences between objects, particles, organisms, quanta and processes with a specific eco-field" (Farina 2000, 21). "A landscape ecological approach helps create more comprehensive landscape designs because it considers biodiversity conservation and seeks to protect water resources with ecologically sound, nonstructural solutions" (Thorne 1993, 36).

Sustainable open spaces, properly designed through site planning and using landscape ecology techniques, protect ecosystems and establish and/or maintain ecological functioning within and for a community, essentially providing for best management practices of environmentally sensitive lands. Tied with the principles of sustainability, landscape ecology offers a win/win situation in the successful establishment of sustainable open spaces in the urban pattern.

Economic benefits of social and environmental sustainability

Sustainable open spaces have the potential ability to bring business into a community and "provide for natural alternatives to expensive projects such as water filtration and flood control" (Labaree 1992, 47). Open spaces may produce economic benefits within a community through the means of protecting a community's watershed, providing for a community back-up water supply in times of drought, and filtrating contaminants through plant species.

Communities that invest in the establishment of open spaces "anticipate and avoid new threats to the quality of life and the viability of ecological systems" (Gouldson and Roberts 2000, 19). Open spaces that are developed with nature and existing environmental services or sensitive areas, "are the economically valuable benefits to society that natural areas provide" (Kaiser, Godschalk, and Chapin, Jr. 1995, 172). Economic benefits may be derived from the following: creation and protection of soil, stabilization of water-flow patterns, amelioration of climate, breakdown of pollutants, recycling of wastes, provision of fish nurseries, and protection against weather damage (Kaiser, Godschalk, and Chapin, Jr. 1995).

Arendt (1999) lists five different explicit measurable economic advantages of conservation design in a community. The first advantage he lists is that of ***lower costs***. By designing around and with nature, infrastructure engineering and construction costs are avoided as well as the costs of transforming fields, meadows and woodlands (Arendt 1999).

The second advantage that Arendt (1999) lists as an economic advantage to designing with conservation occurs during the ***marketing and sales*** period. "When developers and realtors can capitalize on the amenities that have been preserved or provided within that development" (Arendt 1999, 88-89). "When given a choice, consumers have demonstrated their clear preference for buying homes that look out onto open space rather than houses from which the only view is that of their neighbor's picture window or backyard" (Arendt 1999, 89).

The third advantage of conservation design and the positive influence of open space is that homes and other residential property surrounding open spaces ***appreciate in value*** faster than those homes found in conventional development surroundings (Arendt 1999). "The natural areas that are preserved and the recreational amenities that are provided in such communities help to reduce the demand for public open space, parkland, playing fields, and other areas for active and passive recreation" (Arendt 1999, 90).

Arendt's fourth advantage specifically involves planning or planning ahead to set guidelines or rules within subdivision ordinances as development occurs, such as the compliance that each new development must contain or develop a bike trail or that for every so many of a population, so much acreage of open space must be established or set aside within the community. Ordinances are discussed more in Chapter 5, *Implementation*.

The fifth advantage that Arendt (1999) lists as an economic advantage to conservation design is a ***smoother review*** of site plans when introduced to residents and presented to county officials. The purpose of acquiring or encouraging the preservation of open space may not be a financial one, but acquisition is nearly always susceptible to financial justification.

Through the preservation of environmentally sensitive areas, sustainable open spaces may provide economic benefits within a community. Sustainable open spaces are capable of providing aesthetically pleasing areas to live near and recreate in, and benefit the community economically by attracting new residents. Overall, through a natural provision of environmental services, sustainable open spaces have the ability to generate revenue for a community.

Conclusions

This chapter defines terms used in subsequent chapters and offers perspective into sustainable open spaces. An explanation and background about open spaces was provided, and the term open space was defined for this thesis. Also introduced were the principles of sustainability, an established justification of sustainable open spaces, and the benefits derived from establishing a sustainable open space within a community. The topic of sustainable open spaces can be a very broad one; the purpose of this literature review is to help focus the discussion.

The history of the role of open spaces in the urban environment starts with the aesthetic concerns of the City Beautiful movement and Frederick Law Olmstead. Both regional planners and rural planners have sought to integrate environmental functions and regional fit with town form. Differing definitions by authors of what an open space was led to its definition for this thesis. Open spaces were related and connected to communities using sustainability principles. Sustainability, in relation to open space, was explained from the three pillar (or principle) aspects of social value, environmental value, and economic value; open spaces hold many benefits within these three values.

As discussed, the social, environmental, and economic values of sustainable open spaces may directly benefit a community in numerous ways. The integration of a sustainable open space within a community states a commitment on the part of that community and represents that community's dedication to ensure and maintain an economically desired quality of life for its resident citizens.

Sources quoted in the literature review each contained their own strengths and weaknesses. The most noted strength of literature review sources reflected on the importance of open spaces as functions of the environment, and as social functions. Many sources, in reference to sustainability, mentioned the inherent human need to be near or surrounded by nature for physical/recreational and psychological/mental capabilities. Few sources mentioned or adequately represented the economic value function of sustainability.

The Department of Housing and Urban Development's 1965 publication, the oldest cited source included in the literature review, provides that the issue of urban sprawl is not new to communities and authors. It has become increasingly important that communities protect and preserve environmentally sensitive areas and plan for sustainable open spaces. All of the authors cited in the literature review shared a common concern towards nature and the environment relevant to implementing sustainable open spaces in local communities.

CHAPTER 3. METHODS

Methods pertaining to the development of a conceptual open space planning process model are explored in this chapter. They rely on the following: (1) the planning process; (2) a review of planning process models; and, (3) open space criteria and a justification of selected natural resource factors as environmentally sensitive. An analysis and evaluation of GIS and its ability to aid in decision-making and act as a planning tool is also included in this chapter. Additionally, methods pertaining to the demonstration model displayed in Chapter Four are described.

The Planning Process

Planning is said to be a "determined effort, through democratic institutions for collective decisions, to make intensive, comprehensive and long-range forecasts of future trends and to formulate and execute a system of coordinated policies framed to have the effect of bending the foreseen trends towards realizing our ideals, spelled out in advance as definite goals" (Bradbury 2001). In planning, the relationship between goals, policy-making, and social consequences must be acknowledged (Hoch, Dalton, and So 2000). These relationships form an interfused system making up the planning process.

Formulating goals with the comprehensive plan

A comprehensive plan is a "tangible representation of what a community wants to be in the future" (Kelly and Becker 2000, 43). The development of a comprehensive plan for a community dictates community goals and plans for citizens to follow and adhere to in the upcoming years. "[Comprehensive] plan preparation typically is a multiyear process in which planners work closely with residents and other professionals to identify and describe community characteristics, articulate goals, and explore alternative plans for the future" (Hoch, Dalton, and So 2000, 24):

> After numerous discussions, draft reports, and public hearings before the planning commission, the legislative body adopts the plan as a policy guide for future local development. Planning staff prepare budgets and ordinances that finance public projects (e.g., streets, parks, and schools) and regulate private development according to the plan policies (Hoch, Dalton, and So 2000, 24).

Just as a building structure needs an architectural blueprint to follow for construction purposes, so too does a growing community in terms of generalizing how land will and/or ought to be efficiently and desirably utilized for future physical development. A comprehensive plan should include all of the land area, or geographical coverage, subject to the planning or regulatory jurisdiction of the local government preparing the plan (Kelly and Becker 2000). A comprehensive plan should also include all subject matter related to the physical development of the community: land use, transportation, water and wastewater, drainage, parks and open space, school sites, other public and institutional activities, floodplains, and wetlands (Kelly and Becker 2000). In addition, the comprehensive plan should include the physical aspects of plans related to economic development and other programs. Comprehensive plans may be broad, including such topics as economic development or recreation, but they must also include all of the physical plans for the community's future.

A comprehensive plan must consider a relatively long time horizon. Professional planners in the United States generally use a time horizon of about twenty years for comprehensive planning; time horizons longer than that tend to exceed the ability to predict and control the future, and time horizons shorter than that are too short to encourage comprehensive thinking (Kelly and Becker 2000). Over a time horizon of twenty years, a community will have the opportunity to change some of the variables, like the location and capacity of roadways and other infrastructure, that affect its future.

Comprehensive plans are devices used to preserve open space through document language. A comprehensive plan, as accompanied by a land-use policy plan map, safeguards urban open land that is limited and fiercely competed for in the market (Shomon 1971, 63). As part of the planning process, comprehensive plans must represent and involve citizens and their interests (Daniels, Keller, and Lapping 1995).

Information gathering and data selection

Community plans ought to provide "meaningful public participation and other assurances that a consensus of [citizens'] ideas and opinions would prevail" (Daniels, Keller, and Lapping 1995, 11). "Although the planner coordinates the [planning] process, it involves elected and appointed officials of the government as well as neighborhood groups, civic groups, special interest groups, and general citizens" (Kaiser, Godschalk, and Chapin, Jr. 1995, 259). Including citizens in the planning process may be done in the following ways: informing the public about the planning process, using volunteers to help gather and analyze data, distributing and collecting surveys, encouraging citizens to offer their ideas and opinions regarding a plan, and inviting citizens to attend public meetings discussing a plan (Daniels, Keller, and Lapping 1995).

Additionally, needs assessments may be done in several ways. The most common data-gathering methods are participatory methods, surveys, and the use of social indicators (Hoch, Dalton, and So 2000). Participatory methods allow groups to have the chance to present their needs and ideas directly to staff and decision-makers. A disadvantage of participatory mechanisms for identifying needs is that some individuals are less likely to participate than others (Hoch, Dalton, and So 2000). "People who are not politically aware or organized, often those who have low social or economic status or who are members of minority groups, or people who are ashamed of their problems, are all likely to stay home (Hoch, Dalton, and So 2000, 341).

Although surveys and social indicators do not offer the public the opportunity to directly participate in developing a consensus on needs, they do provide back information representing the needs of individuals who may not be involved in the participatory process (Hoch, Dalton, and So 2000):

> Surveys use a predetermined questionnaire to ask respondents directly about their needs. A survey can be designed to obtain specific information on topics for which other data is not available. Social indicators, on the other hand, use data collected routinely by government or private groups (Hoch, Dalton, and So 2000, 341).

An assessment of citizens' needs and wants in a community play an important role in influencing the planning process.

Participatory roles in the planning process

In working with communities to implement open spaces, a planner plays an important role. A community encompasses a wide array of citizens, stakeholders, and community groups with varying interests. A planner's job is to work with all of these interests in order to compose a best decision for all. The tragedy of the commons is often cited in relation to a general need for planning and balancing the various interests of a community (Moore 1978).

The tragedy of the commons focuses on the idea that much of the world is treated as a "commons," wherein individuals have the right to freely consume its resources and return their wastes (Hardin 1968). For example, *all* land is part of the commons because it is a component of life support and social systems. Commons may be destroyed by uncontrolled use; an example of uncontrolled use is when one can use land (part of the commons) any way one wants. The logic of the commons ultimately produces its ruins as well as the demise of those who depended upon it for survival (Hardin 1968).

"The tragedy of the commons indicates a particular important public good with which planners are concerned and which the private market supplies: preventing overexploitation of common resources" (Moore 1978, 392). The tragedy of the commons has many different implications which relate it back to sustainability, and moreover, sustainable open spaces. Something that is sustainable has social values, environmental values, and economic values. The logic of the commons parody's impact on land that is sustainable has detrimental effects. For example, an open space serving as a shared resource may be contaminated by run-off erosion from adjacent properties that would thereby negatively affect its environmental value. This same open space may be argued over if access to the property is restricted, and thus considered un-equitable, which then causes a negative impact on the land socially. If the open space's property value is monetarily deemed worthless due to being environmentally contaminated, its economic value is negatively impacted, and its overall land value decreases in cost.

In addition to planners working to prevent the tragedy of the commons and oversee civic obligations, planners' roles involve much more. "In addition to gathering 'facts' and enforcing rules, [planners] balance competing interests and demands and mobilize support for courses of action within and outside of their organizations" (Rich 1977, 335). In balancing competing interests and demands, planners are placed into a politically conflicting arena of responsibility working with community stakeholders where they must act as rational decision-makers.

A rationality in planning includes evaluating and choosing between goals, and involves multiple and often conflicting objectives. "In planning, rationality also implies that a plan, a policy, or a strategy for action is based on valid assumptions, and includes all relevant information relating to the facts, theories, and concepts on which it is based" (Alexander 1992, 40). Planners help organize and oversee individual choices within a community to ensure that the community prospers as a whole. Essentially, planners hold the responsibility to combine diverse needs into a set of strategies to meet the ends, or mutual objectives and goals held by and within a community.

To plan open spaces, and more specifically to plan them sustainably, interaction with many differing interest groups is necessary in order to better define a community and the community's sought after quality of life. Seamon (1993, 38) explains the role of planners in helping to aid in achieving the quality of life social aspect through development integration: "planners play [an important role] in reclaiming and making places. Their task is, first, to develop a sensitivity to the attributes of places and then to find ways of initiating and directing locally committed developments...In short, the task is to find some means of balancing local considerations with broader social and ecological terms." It is important to include the involvement of local citizens in the planning process of establishing and implementing open spaces. The involvement of citizens in designating an open space and be involved in the land-use planning process allows citizens to strengthen their role in a community by building their own channels for expression and accountability (Honadle 1985). Within the social aspect of sustainability, and sustainable development, local action is an essential part of the process.

The relationship between the interests of interest groups and the interests of a community rests in that a community acting as whole, often has broader visions and goals for the future of their community. Meanwhile, interest groups work within those broader visions to produce a result – interest groups work as the components that turn the wheel (or in this case bring the community closer to a vision/goal). A planner must adhere to the needs, wants, and desires of separate community interest groups while working to better the whole community and their interests as an end product. Due to the "inherently selfish nature of interest group advocacy of individual values, a strong coordinating process is necessary to provide analytic, synthetic, and sociopolitical efforts needed to balance and coordinate competing interests" (Kaiser, Godschalk, and Chapin, Jr. 1995, 52).

Overall, a planner must act sustainably, looking at all directions and options and how they will affect one another. Sustainability, when achieved by a community, will meet citizens' desired quality of life standards by providing social, environmental, and economic values.

Planning process models

A conceptual model provides the main structure of a problem and identifies its data, constraints, criteria and objectives (Chic 2 Consortium 1998-1999). Conceptual models in planning should address the identification of a problem and a decision as to which strategy may best be used to solve that problem. Daniels, Keller, and Lapping (1995, 10) model offers a community planning process that addresses information gathering (in order to better analyze a problem), community goals and objectives (to address the problem), and then the choice and implementation of a plan of action (see Figure 2, page 29). This model involves the gathering of information that then leads to an awareness of a community problem. From here, a community's decided upon goals and objectives provide direction regarding how to begin addressing community problems. An identification of possible solutions determines what changes ought to occur, what should be protected and how this change or protection may best be accomplished (Daniels, Keller, and Lapping 1995). A plan of action is eventually chosen and implemented, followed by the monitoring of this plan of action which allows for an evaluation on how well the solution may or may not be working (Daniels, Keller, and Lapping 1995).

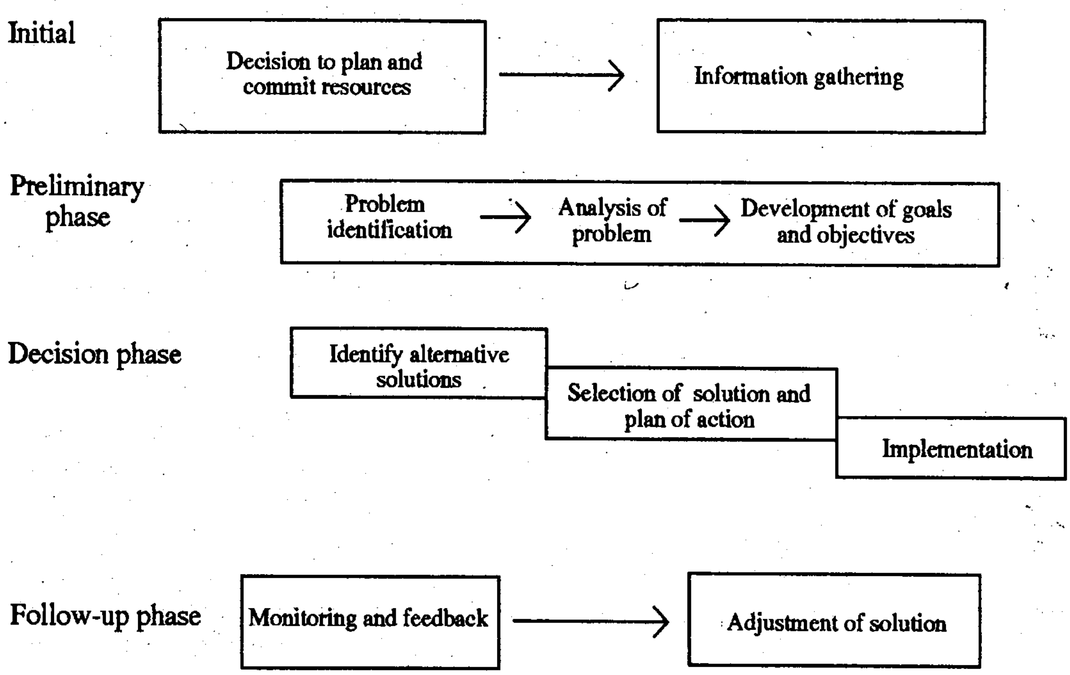

Figure 2. The Planning Process
(Daniels, Keller, and Lapping 1995, 10)

An assumption of the model may be that within the determination and identification of solutions (as included in the decision phase of the Daniels, Keller, and Lapping 1995 model), that some kind of needs assessment was conducted during the initial phase in order to gather citizens' views and opinions. One of the drawbacks of the model shown in Figure 2 is the lack of a citizen participation component as part of the planning process. By not including citizen participation in this model's planning process, the social value of sustainability is not appropriately addressed. In addition to the social value being neglected in this model, the other principle values of sustainability – environmental and economic – are not directly referenced, and therefore are not necessarily linked to this model.

A planning model containing similar methodology components found within the Daniels, Keller, and Lapping (1995) planning process model is offered by Hoch, Dalton, and So (2000, 25). This model (see Figure 3, page 31) is very comparable to the previous model in its steps and/or phases, yet includes a citizen participation component that the Daniels, Keller, and Lapping (1995) model lacks. The planning process shown in Figure 3 (see page 31) was used in Seattle during the 1980's and, "included interchange between citizen groups and planners. Citizens actively commented and also shaped alternatives for meeting planning objectives. As a result, the plan successfully incorporated many viewpoints and interests" (Hoch, Dalton, and So 2000, 25). Citizen participation, as included in the Hoch, Dalton, and So 2000 model, is shown to affect all stages of development within the planning process.

The Hoch, Dalton, and So 2000 model is limited to environmental review only and therefore fails in adequately providing a sustainability review within its planning process. The other two principles of sustainability, social and economic values, must also be included in the process for the model to function successfully. Additionally, this model is limited in its failure to reference a means to develop plans (Step 5 of the model), and/or how to determine solutions. This should be included as a step in the model between step 4 ("revise goals and determine objectives") and step 5 ("develop and evaluate alternative plans").

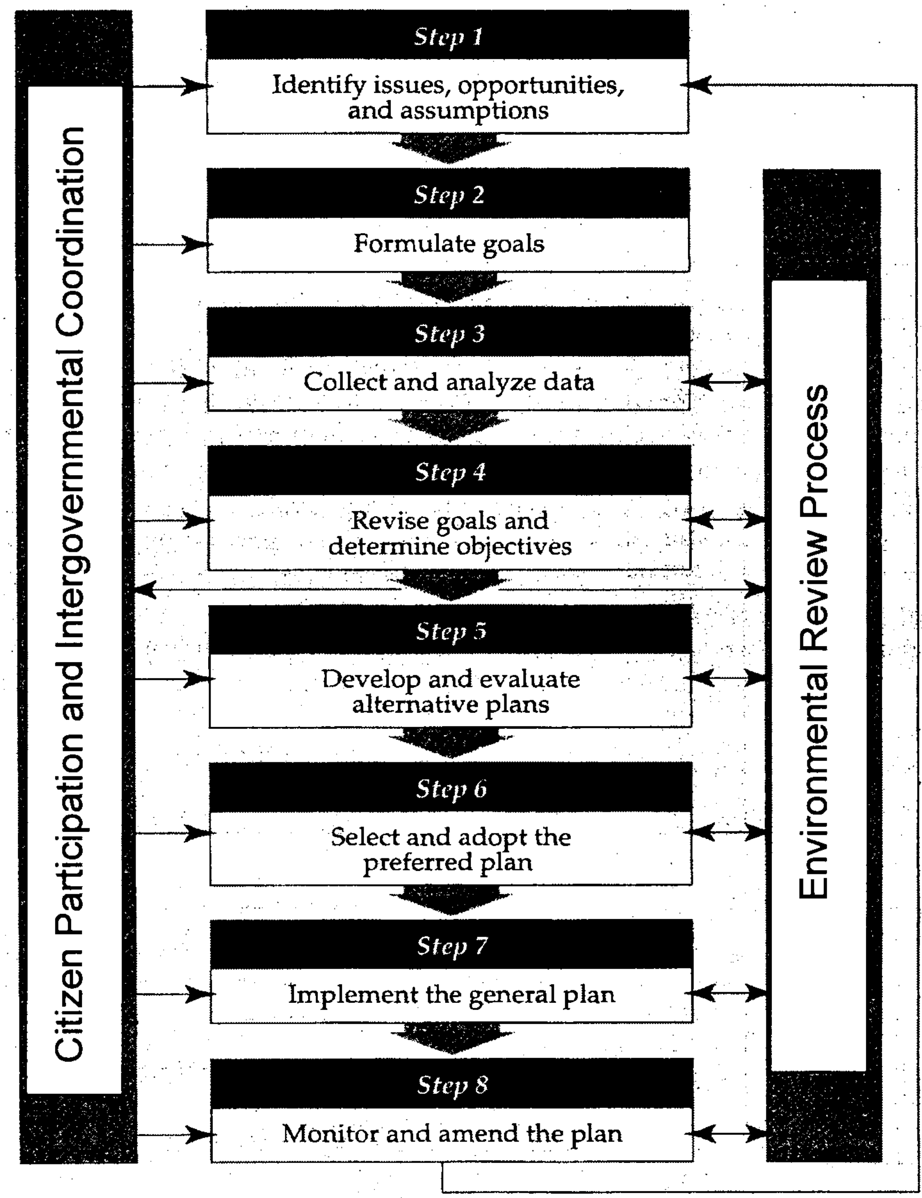

Figure 3. General Plan Process
(Hoch, Dalton, and So 2000, 25)

A model for applying a GIS based method to land-use policy and change is shown in Figure 4 (see page 32). This model provides a conceptual "means of evaluating a plan, policy, or directive in terms of both its direct and indirect consequences on the biophysical and socio-economic environments" (Haines-Young, Green, and Cousins 1993, 224).

The framework of the model in Figure 4 is intended to provide a logical sequence for evaluating a plan or policy (Haines-Young, Green, and Cousins 1993). "Direct consequences can be predicted using land use models while indirect consequences on the biophysical and socio-economic environments are predicted using models for impact assessment" (Haines-Young, Green, and Cousins 1993, 224). Haines-Young, Green, and Cousins' model begins with land-use policy, and jumps to the decision-phase of Kaiser, Godschalk, and Chapin, Jr.'s model (1995; see Figure 2, page 29). The model in Figure 4 also jumps to where step five begins in the Hoch, Dalton, and So model (see Figure 3, page 31). Moreover, the inclusion of environmental and socio-economic impact assessment as a component in the model addresses the other models' failure to correlate the planning process with the sustainability principles.

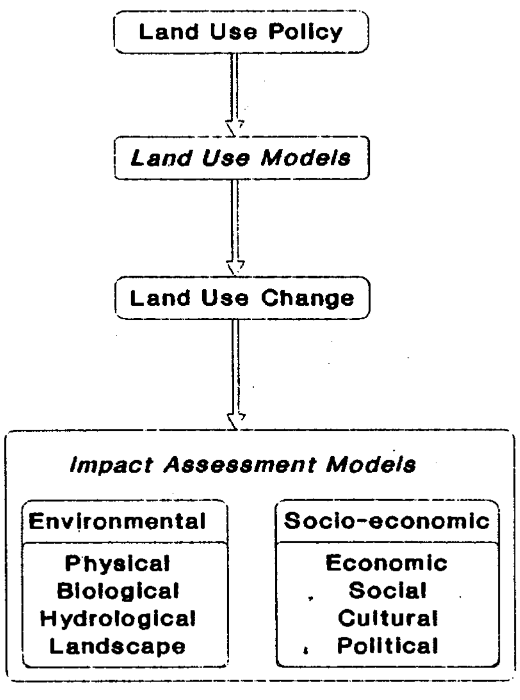

Figure 4. GIS-Based Methods Model
(Haines-Young, Green, and Cousins 1993, 224)

The model in Figure 4 (see page 32), unlike the two previous models, "allows plans, policies and directives to be tailored to produce desired effects and is a contribution to decision-making processes and policy *formulation* rather than merely a system for policy *interpretation*" (Haines-Young, Green, and Cousins 1993, 224). The "land-use model" component included in the model allows for a means to develop plans and/or determine solutions. Using this model, land-use policy (or goals and objectives/criteria) can be interpreted within GIS using a modeling approach. Output in the form of maps showing areas in which land-use changes are more likely to occur provides a direct feedback to policy and allows land-use implications to be discussed (Haines-Young, Green, and Cousins 1993). "This level of interpretation and critical examination of likely consequences of policy will, in itself, significantly improve the possibility of obtaining desired land-use outcomes" (Haines-Young, Green, and Cousins 1993, 224). Also included in Figure 4 (see page 32) is a socio-economic assessment component. The inclusion of this component in the Haines-Young, Green, and Cousins 1993 model is significant. Although socio-economic does not directly refer to citizen participation, it may be implied as a main social factor in determining the assessment.

The three planning process models discussed above each contribute to the methods and creation of a conceptual open space planning process model for this thesis. The creation of this model used Kaiser, Godschalk, and Chapin, Jr.'s 1995 model with its phases (see Figure 2, page 29) as its main component and added the component of citizen participation from the Hoch, Dalton, and So model (see Figure 3, page 31).

Conceptual Open Space Planning Process Model

The creation of the conceptual open space planning process model (see Figure 5, page 37) involved a combination of several different phases to form a process. Four phases contribute to the model:

PHASE I (INITIAL) - Problem Identification and Community Goals/Objectives:

In the case of identifying a problem or issue in a community, citizen participants should work with community planners and intergovernmental staff in order to determine a consensus of goals and objectives. "Goals and objectives [of a community] are statements of policy: recommendations of what needs to be done and how. Goals are necessary to assure that the needs and desires of the community are understood" (Daniels, Keller, and Lapping 1995, 20).

Citizen participation in the planning process serves an important role in helping the planner obtain a comprehensive assessment of what diverse goals and objectives are present within a community. A comprehensive plan may broadly provide a collaborative assessment of what a community's goals and objectives are. However, comprehensive plans sometimes span a time period of 20 years and are therefore not necessarily updated sources of information. For this reason, it is important for citizens to always have an active role as participants in the planning process. Distributing surveys to the public or establishing a citizens' advisory board in order to receive input/feedback regarding resident's desires of their community are common techniques to gain an update on citizens' community goals and objectives. Once determined, a planner may use a community's goals and objectives as "vision tools" to better plan and work towards solutions that will aid in achieving a desired quality of life for residents.

PHASE II (PRELIMINARY) - Collect and Analyze Data (Criteria/Factor Selection):

This phase serves as the preliminary phase to approach and aid in the decision-making phase of the planning process (PHASE III). This phase's role in the conceptual model may also be referred to as information gathering and data collection. The collection of information and data allows a community to be aware of their allocation of resources and the achievability of community goals and objectives based upon those resources.

Planners and/or intergovernmental staff may use citizen participants' recommendations of resources as criteria to aid in decision-making. The selection of criteria, or data, aids participants in the planning process in defining and articulating their values (Hobbs 1994). A quantification and communication of resource priorities as data and/or criteria may help citizens, planners, and intergovernmental staff negotiate the aspects and dynamics of an open space (Hobbs 1994). In particular, citizens' input is needed in order to weight and rate resources. The technique of weighting and rating is a common GIS method that, using a scale of 0-100, allows participants to assign a weight to criteria (Hobbs 1994). "Weights are the means by which methods determine how much of one attribute the decision maker is willing to give up for another" (Hobbs 1985). Using this method, selected criteria components amount to a totaled score, which thereby affects and determines resource choices. In relation to the establishment of an open space, the allocation of scores to criteria could include the ability of a community to acquire resources and/or purchase a piece of land. Weighting and rating is discussed in more detail later in this chapter.

The inclusion of this preliminary phase in the planning process improves a community's ability to make better, more informed decisions. Knowledge of available resources, as well as citizens' needs and desires, contributes to a community's awareness, and allows that community to revise goals and objectives accordingly (and, thereby, realistically) when approaching a problem/issue.

Means to Determine Solutions:

A community's chosen selection of factors and criteria, derived from a community's goals and objectives, serve as data input. For the purpose of establishing open spaces, citizens and planners must cooperate to analyze and edit this data in order to arrange for a solution. The use of GIS as a means to determine potential solutions is recommended as an analysis tool for implementation strategy in this thesis. Because it is important to include citizen participation involvement in the process of locating sites to establish open spaces, the ModelBuilder extension of ArcView GIS version 3.2 is recommended.

The ModelBuilder extension provides a user-friendly means to spatially determine open space site solutions by allowing edited data to be weighted and ranked based upon a community's selection of criteria. The demonstration model (see Chapter 4, *Results*) involves the use of GIS as a tool in planning and as a means to determine solutions. The use of GIS in this way and as a part of the planning process, effectively aids a community in their decision-making of where to establish an open space that will meet sustainability principles.

PHASE III (DECISION-MAKING) - Selection of solution and implementation:

From a community's visions and goals, their data (or natural resource factors and criteria selection), and the use of GIS as a tool and means to determine solutions through data analysis, potential solutions towards approaching a problem/issue are identifiable. Citizen participation and coordination with a community's planner and/or intergovernmental staff is critical in this phase in order to compromise a common solution towards solving the problem identified in PHASE I. While there is no guarantee that consensus will be reached, it is important to re-assess previously identified citizen participants' values in this phase in order to ensure that the chosen solution will work towards citizens' common goals.

It is within this decision-making phase of the planning process that a community's plan is "put into action" by implementing an agreed upon solution. Implementing an open space within a community may be done through the drafting and application of land-use regulation techniques discussed in Chapter Five. These techniques include zoning ordinances and subdivision regulations. Regulation techniques allow planners and citizens to control the future growth of their community and protect implemented open spaces.

PHASE IV (FOLLOW-UP) - Monitoring, Feedback, and Solution Adjustment:

Plan evaluation is "the systematic assessment of environmental, social, economic, fiscal, and infrastructure implications of land use and development management plans" (Kaiser, Godschalk, and Chapin, Jr. 1995, 426). Plan evaluation criteria and methods are beneficial in assessing the impacts of proposed and adopted solutions in the planning process, and in estimating the degree of achievement of goals and objectives, the distribution of benefits and costs, and the feasibility of implementation (Kaiser, Godschalk, and Chapin, Jr. 1995).

In reviewing an implemented solution in the form of an established open space, a community needs to determine whether or not that open space meets sustainability principles. Feedback from citizen participants, planners, and intergovernmental staff will help determine the success of an implemented solution. This review analyzes and assesses the location of an open space and determines its ability to be productive environmentally, socially, and economically within a community. If an implemented solution is not effective in meeting these sustainable values, it does not serve the purpose of a sustainable open space. Should this be the unfortunate case, the planning process begins again from the initial phase, again determining what a community's goals and objectives are, and how they ought to be included in the overall schematic and implementation of solutions within the planning process.

The most important, emphasized component of the conceptual open space planning process model (see Figure 5) is the involvement of citizen participants and their interactions with planners and/or intergovernmental staff. Moreover, citizens must be kept informed during the planning process, but must also keep an open dialogue and inform planners and intergovernmental staff with how the plan is foreseen from their perspective as well.

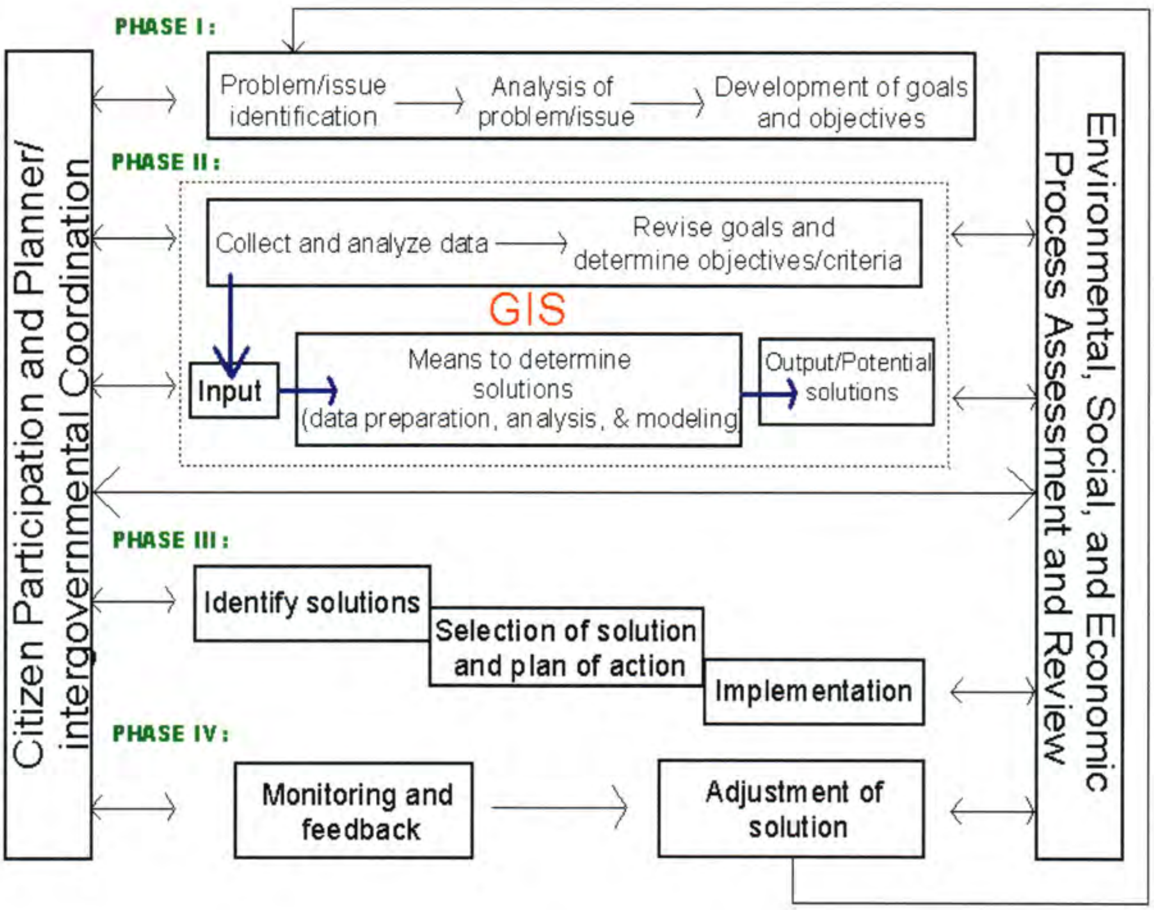

Figure 5. Conceptual Open Space Planning Process Model

The model shown in Figure 5 (see page 38) conceptualizes a planning process that a community may use for direction to implement a sustainable open space. The presentation of the conceptual open space planning process model, as followed, provides for a systematic series of "checks and balances". These checks and balances (presented as arrows in Figure 5, see page 38) involve citizen and planner/intergovernmental cooperation and an environmental, social, and economic (or sustainability) process assessment and review at each phase of the planning process. Therefore, to go through the entire process and have the result of an open space that failed to meet all three pillar values or principles of sustainability would most likely indicate a missed step or proceeding within one of the phases. Planning is a continual process and is always occurring. The conceptual open space planning process model (see Figure 5, page 38) shows a continual process, with one phase reflecting and feeding into another.

The blue arrows illustrated in the model represent the inclusion of GIS as part of the open space planning process and as a means to determine solutions. In this model, the collection and analysis of data (in this case natural resource factors and/or environmentally sensitive area attributes) in the form of revised objectives/criteria serves as input into a GIS. Using GIS as a means to determine solutions, this input is analyzed based on a community's criteria assessed from goals and objectives.

The use of GIS as a tool in the planning process may aid a community in identifying and deciding upon a solution based upon its ability to produce visual maps. In this way, the conceptual open space planning process model is not limited to the use of GIS and remains open to other tools or applications to serve as a means to determine solutions. Moreover, GIS is not the only available means to determine solutions in the planning process. Other available means beyond GIS that may aid in establishing and implementing open spaces are discussed and described in Chapter Four. The choice of method or a means to determine solutions in order to solve a problem in the planning process ought to be a collaborative decision made by citizens, planners, and/or intergovernmental staff.

The conceptual open space planning process model provides a basic framework towards the implementation and establishment of sustainable open spaces. Model conceptualization is a generalized form of the actual formulation process. It is necessary to conceptualize the model so that its component parts may be effectively formulated. Now that a general conceptual vision of the model has been established, the next step is to illustrate the conceptual vision of the planning process using a demonstration model. The demonstration model uses GIS as a means to determine solutions as alluded to in PHASE II of the planning process (see Figure 5, page 38). Methods in preparation for the formulation of this demonstration model are discussed below. The actual demonstration model is displayed in Chapter 4, *Results*.

Sustainable Open Space Criteria

For this thesis, an open space was defined as one that serves the function of protecting environmentally sensitive land, and that provides social recreational services for the enjoyment of local citizen populations. Another way to define open space is to describe open space attributes. These attributes, or factors, are more or less desirable for the preservation of open spaces. Selected factors, as identified by communities, serve as data or input into the planning process model (see Figure 5, page 38). Factors, as criteria, aid in ranking land in order to prioritize site locations that ought to be set aside and protected for the establishment of open space.

Natural resource factors play an important role within the definition of a sustainable open space. Environmentally sensitive areas are considered a constant in the definition of sustainable open spaces for this thesis. Identifying natural resource factors and then analyzing each factor in terms of justification allows for better land-use management and the protection of environmentally sensitive areas. Factors defining the values and characteristics associated with the preservation of open space, or what makes a given piece of land useful as functioning as open space may include the following: scenic and unique land form values, cultural resources, natural areas, buffer zones, trail corridors, recreational values, development pressures, and city and recreation district priorities (Trust for Public Land 2001).

Citizens, community groups, and planners all play a role in identifying and mapping environmental factors. Once these factors are identified and mapped, they may be used to help a community evaluate potential threats and establish priorities for future and current land purchase and protection. The end objective of identifying natural resource factors is to produce an efficient process in land-use planning and development.

Many communities base their decision to acquire land for open space purposes on the ranking of criteria as determined from a chosen selection of factors reflecting common community interests (Trust for Public Land 2001). To attempt to conserve environmentally sensitive land and find appropriate locations for open space development, a community must first determine the ranking and weighting of selected criteria. The ranking and weighting of selected criteria will vary with each individual community in reference to community values. Moreover, what data (or factors and criteria) are selected should be appropriate to the community for which an open space is intended to function. Using selection criteria, a community is able to better choose the location of an open space based on community goals and needs.

The following criteria are recommended to evaluate potential lands considered for open space purposes (Trust for Public Land 2001):

- **Financial status.** Is there a financial incentive, such as a cost share, installment purchase, bargain sale, partial donation, conservation easement, etc.?
- **Location.** Is the land within a targeted acquisition area? Does the property serve as an extension of linkage to existing preserved open space or farmland?
- **Development pressures.** Is the land in imminent danger of development? Is the parcel large enough to reasonably expect it to contribute to urban sprawl?
- **Public support.** Does the acquisition of the parcel have widespread support? Will the property benefit more than one neighborhood or the county at large?

In addition to these criteria, a community ought to evaluate and consider existing land-use policy and/or regulation of potential land to serve the purpose of an open space as well. Identified, a community may separate factors based on importance as determined by a needs assessment or otherwise, thereby creating a process that ranks factors and formulates criteria. A community using criteria is able to establish and justify a selection of factors, in terms of prioritizing property to be considered for open space purposes, and with the importance of preserving environmentally sensitive areas in their community in mind. Selection criteria for open space purposes, and as recommended by the Trust for Public Land (2001), may include the following:

- Ecosystem preservation/species diversity (critical wildlife habitat or endangered species as identified by the IDNR, plant life, etc.)
- Significant geological formations or unique landforms.
- Cultural/historical, or archeological resources;
- Potential for "linkages" to other properties or trails for public access;
- Potential for recreational opportunities;
- Conservation of natural resources (freshwater wetlands, forested areas, groundwater recharge areas, water quality, steep slopes, stream corridors, etc.)
- Serves multiple purposes; and

- Accessible to the public (either directly through passive recreation or trails, or indirectly by being visible and appreciable by residents and visitors).

In addition to the list above, a community's criteria for open spaces may also be derived with the following goals in mind (Trust for Public Land 2001):

- Protect and improve water quality
- Protect and improve wildlife habitat and biodiversity
- Provide open spaces in high density neighborhoods
- Protect scenic vistas and areas of cultural significance
- Provide adequate space for both active and passive recreation needs of the community

Additionally, a community ought to look at connectivity and engage in ecology attribute identification when determining factor priority. "The overall goal for planners is to maintain extensive, well-connected areas of open space… To achieve this goal, the best approach is to plan for the entire landscape: to consider and coordinate the whole range of land uses and jurisdictions" (Peck 1998, 70). Connected environmentally sensitive areas allow for advanced ecological processes such as habitat increase. The involvement and cooperation of citizen participants with planners is important in the process of selecting factors and ranking criteria for ecological purposes. "Maintaining area and connectivity requires cooperation among multiple owners and decisionmakers" (Peck 1998, 70).

To aid a community in factor and criteria selection, the following section describes a general knowledge of environmentally sensitive physical landscape formations and their interrelationships. A justification of environmentally sensitive areas and natural resource factors needs to be addressed in order for a community to adequately select factors for the purpose of criteria ranking.

Justification of natural resource factors

The importance of factor selection rests in the idea that if natural and cultural features are to be protected and saved for future generations, it is essential to map and create an inventory of these sensitive environmental patterns. Furthermore, areas requiring protection from future development are realized through the identification of resources.

Generally, environmentally sensitive areas are characterized by the following natural resource factors: wetlands, stream corridors, steep slopes, wooded areas, hydric soils, habitat for endangered or threatened plant and animal species, prairie remnants and archaeological sites and areas with scenic vistas (Iowa City, City Council 1995). The identification of environmentally sensitive areas that include any or all of these selected natural resources ought to be protected in a community. Where natural resources exist in a community, the most responsible allocation of their use, from a land-management perspective, is as open space (Kaiser, Godschalk, and Chapin, Jr. 1995). Where natural resources cannot be protected as open space in new development, a community (or private conservancy group) ought to seek their protection through acquisition, leasing or development transfer provisions (Kaiser, Godschalk, and Chapin, Jr. 1995). Natural and/or environmental resource factors to be considered in site analyses of sustainable open spaces may vary from community to community.

The City of Bloomington, Indiana (COBERI 2002) conducted an environmental resource inventory for the purpose of collecting pertinent information about Bloomington's environment in an effort to digitally map and prioritize the community's natural and cultural resources. The produced digital maps prioritizing these resources are to be integrated into Bloomington's on-going planning process which strives to develop sustainable land-use and land development strategies for the City (COBERI 2002). Similar to Bloomington's process, the conceptual open space planning model (see Figure 5, page 38) integrates a community's selection of natural resource and environmental factors as input within the preliminary phase, or PHASE II. The following factors, as recommended by COBERI (2002), ought to be considered when planning for the purpose of establishing sustainable open spaces:

- **Brownfields / Contaminated Land** – It is necessary to identify potential hazards and risk to human health prior to designating zoning and land use activities. The redevelopment of brownfield sites as open space may be beneficial to a community and the environment (COBERI 2002).
- **Conservation Land** – Conservation land includes conservation easements as well as any land acquired by public land trusts (COBERI 2002).
- **Cultural Resources** – Identifying the land locations of cultural resources with historic, archeological or cultural significance allows for the preservation and enhancement of these resources. Cultural resources serve as important educational, recreational and social resources to any given community.
- **Floodplains and Waterways** – Floodplains are natural flood overflow areas adjacent to stream channels. A floodplain (see Figure 6, page 46) includes the stream channel and its over-bank area, as well as the adjacent floodway fringe. The *floodway* (the channel of a waterway or streams, rivers, creeks, etc.) should be included as environmentally sensitive also as the floodway is considered the "danger zone" where destructive flooding statistically is most likely to occur (Kaiser, Godschalk, and Chapin, Jr. 1995).
- **Parks, Pathways, and Trails** – Sensitivity to the locations of parks, pathways, and trails are essential in order to effectively plan for recreational development.
- **Sensitive Habitat** – The locations of plant and wildlife habitats provide important environmental information.
- **Soils** – Soil types and their locations are important for planners to consider.
- **Topography** – The topography of the landscape is important because it influences the potential for erosion, as well as special planning and design provision that must be acknowledged (Kaiser, Godschalk, and Chapin, Jr. 1995; see Figure 7, page 47).

- **Vegetative Covers** – It is valuable to locate and identify the different types of vegetative cover during the planning process.

- **Wetlands** – Wetlands are marshes, swamps and similar areas located between rivers, lakes and oceans and the adjacent dry land. Wetlands perform important environmental functions.

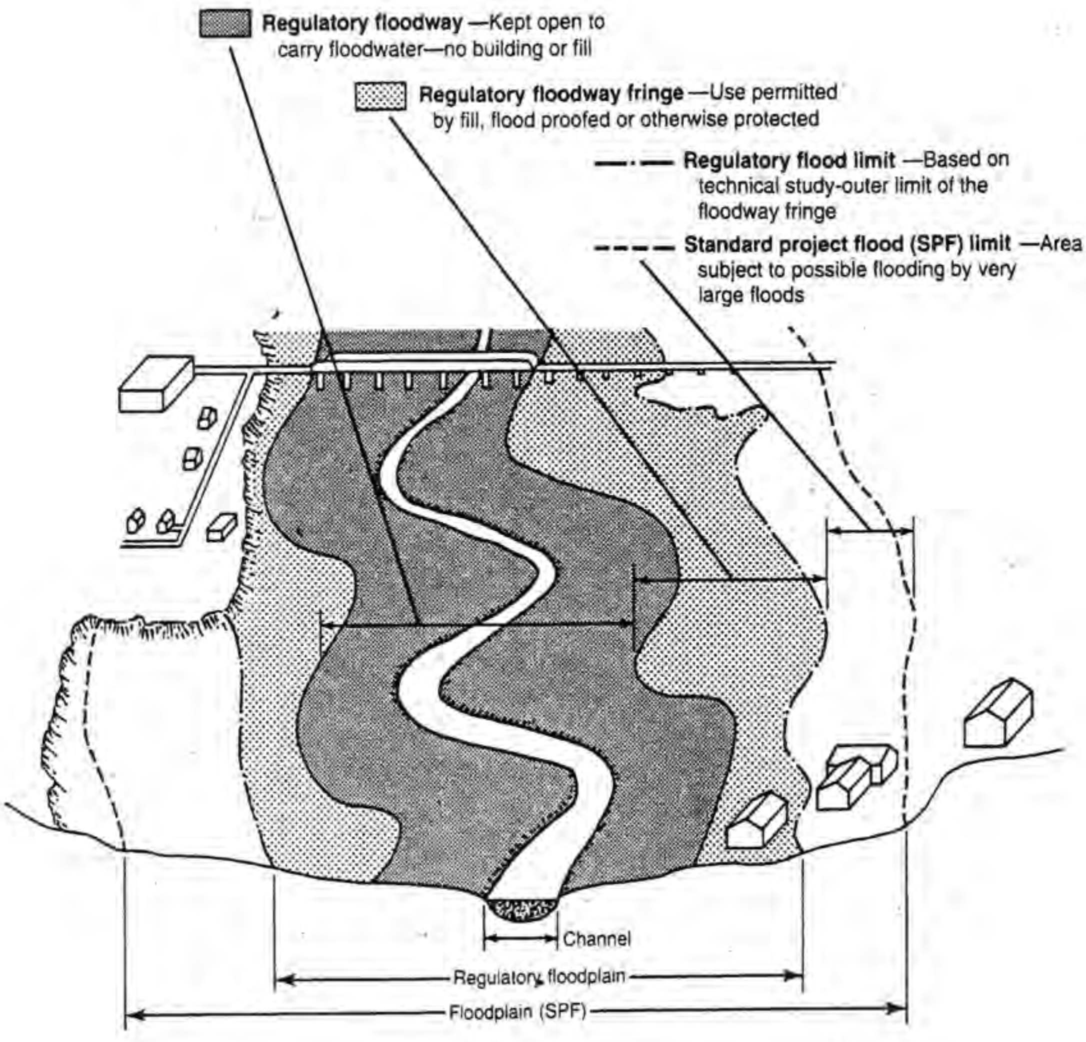

Figure 6. Flood Hazards Associated with Rivers & Streams (Source: Kaiser, Godschalk, and Chapin, Jr. 1995, 183)

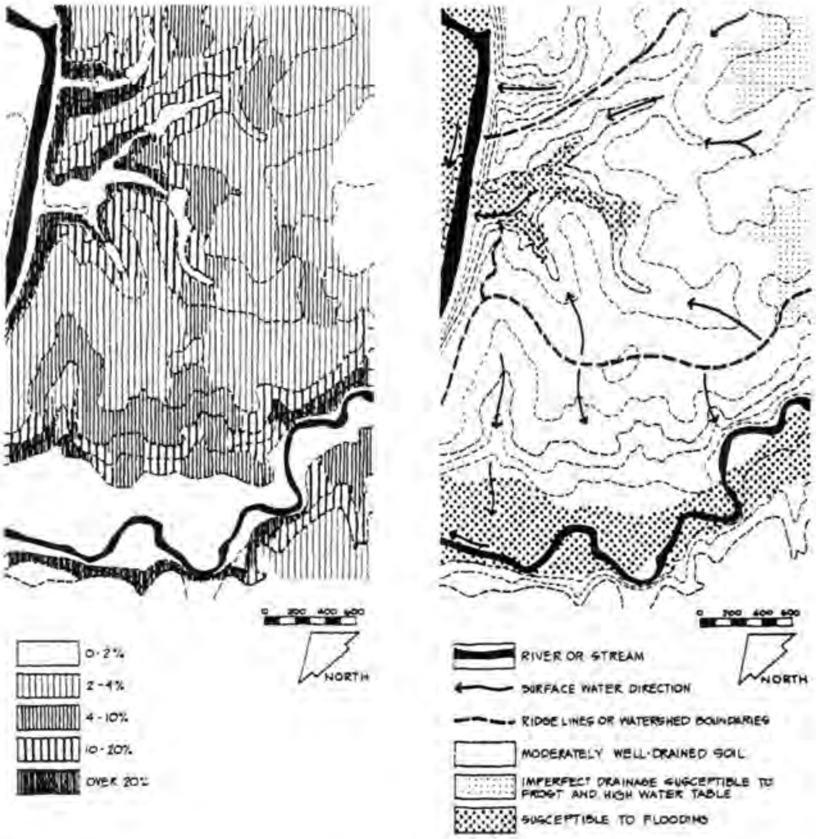

Figure 7. Slope and Watershed Maps
(Source: Kaiser, Godschalk, and Chapin, Jr. 1995, 178)

Nature is a web with many interconnections. The factors listed above provide a profound connection of open space to nature and the environment; for a more detailed list of COBERI factor descriptions, refer to Appendix B.

Discussion and Exploration of GIS

In open space preservation, GIS is a proven tool of value for developing information that improves protection activities. A GIS, with its mapping capabilities and allowance for data input, provides a process in which planners can utilize a methodology for evaluating potential land acquisitions for the establishment of an open space. GIS is a computer-based tool for mapping and analyzing land (Environmental Systems Research Institute, Inc. 1988). This system can assist decision-makers by identifying those land areas permanently protected, temporarily protected, and vulnerable to development, as well as providing overlays that demonstrate the interrelationship among natural resources, open lands, and the community (Environmental Systems Research Institute, Inc. 1998). GIS may be used to a community's advantage through the display of mapped elements when attempting to sway an audience or a group of community citizens, in order to form a decision surrounding land-use.

Using a GIS, a user influences the hardware, which engages the software, to work on the data (Environmental Systems Research Institute, Inc. 2002a). These steps, taken together, can handle the following (Environmental Systems Research Institute, Inc. 2002a):

- Computerizing of information (data entry, either through digitizing, scanning, keyboard entry, or data transfer)
- Data selection and query (information processing through database manipulation and advanced math analysis functions)
- Data display (map creation through drawing capacity)

The use of GIS allows spatial information to be stored in a computer based on different layers or themes (Stone and Schindel 2002). "A theme is data organized by subject matter" (Stone and Schindel 2002, 40). For example, wetlands data can be grouped together into a single theme. "As relevant data sets are identified and gathered, GIS technology allows the various layers to be queried to determine relationships, or quantified for scoring and ranking purposes" (Stone and Schindel 2002, 40). For example, you could use this process to indicate all properties within 10 miles of an existing park that are at least 24 acres in size, and contain specific natural resource factors.

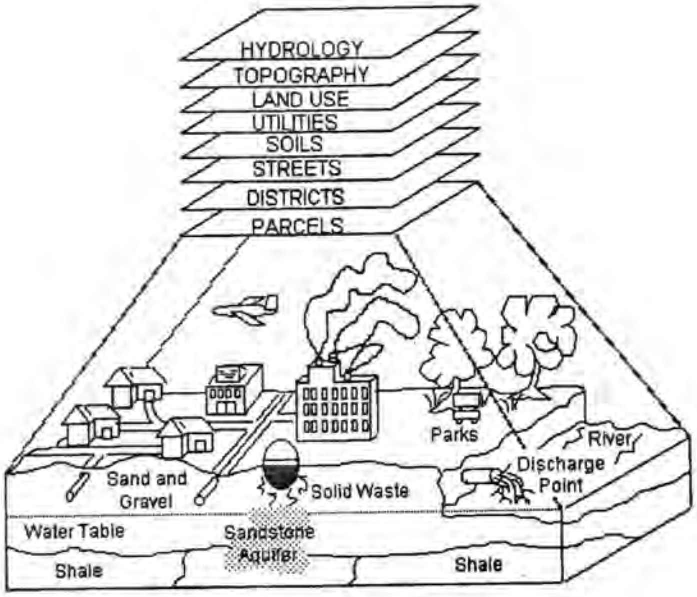

Figure 8: GIS Data Display: "The real world consists of many geographies which can be represented as a number of related data layers" (Source: Environmental Systems Research Institute, Inc. 2002a)

GIS is an effective tool because it allows one the ability to associate information with features on a map and to create new relationships that can determine the suitability of various sites for development, evaluate and calculate environmental impacts, identify the best location for a new facility, etc. GIS, with its mapping capabilities and allowance for data input, provides a process in which planners can use a method for evaluating potential land acquisitions for the establishment of an open space. Moreover, the input of natural resource factors and criteria into a GIS (as selected through a community consensus technique) allow planners to narrow potential land acquisition sites considered as candidate areas for the placement of a sustainable open space.

Vector versus raster data

The range of spatial data types currently used in most GIS systems is largely determined by the vector or raster data models they implement. To explain raster data and vector data and the differences between the two, it is important to understand that GIS data is logically divided into two categories: spatial (geometric) data and attribute (non-spatial) data (Foote and Huebner 2000). Vector and raster data models are used for graphic representation of geographic space. In a vector data model, topology (i.e., points, lines and polygons) is used and the relationship among different features is maintained spatially in a GIS (Foote and Huebner 2000; see Figure 9, page 50). In the raster data model, a grid-cell or pixel representation is used; Digital elevation model (DEM), and scanned aerial photos are examples of raster data (see Figure 10, page 50). Vector and raster representations of geography features in GIS focus on database management, query and spatial analysis (Rhind 1990). Attribute data are characteristics about geographic features. In both vector and raster data presentations, links are established between and connect attribute information and spatial features.

Vector data are often considered most favorable for editing feature attribute information (Rhind 1990). Links are established by arranging unique identifiers for each spatial feature to be recorded in the fields of the appropriate database tables used to store attribute information. Based on these created identifiers, data is retrievable, and associations are developed.

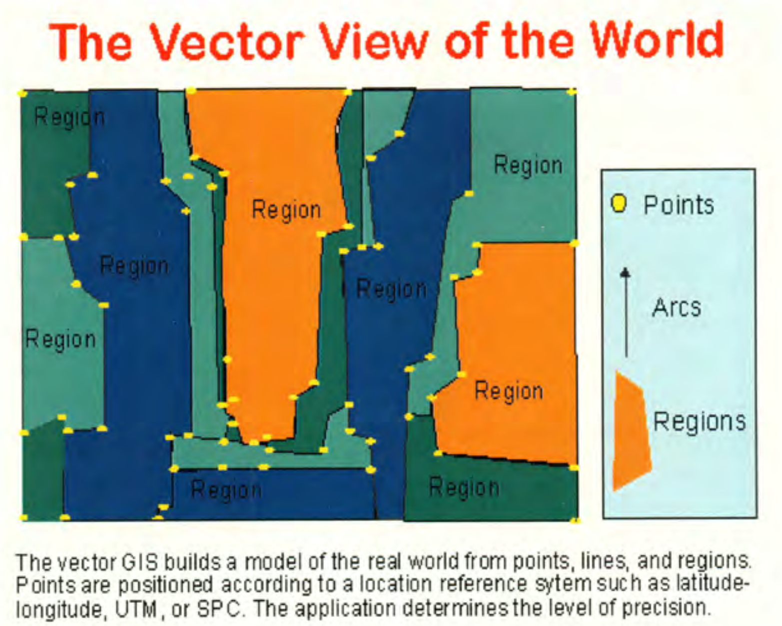

Figure 9. Vector Data Model
(Source: Foote and Huebner 2000)

In contrast, raster data links are implicit in the way that specific attributes are assigned to individual layers and values specified for pixels or cells in each layer.

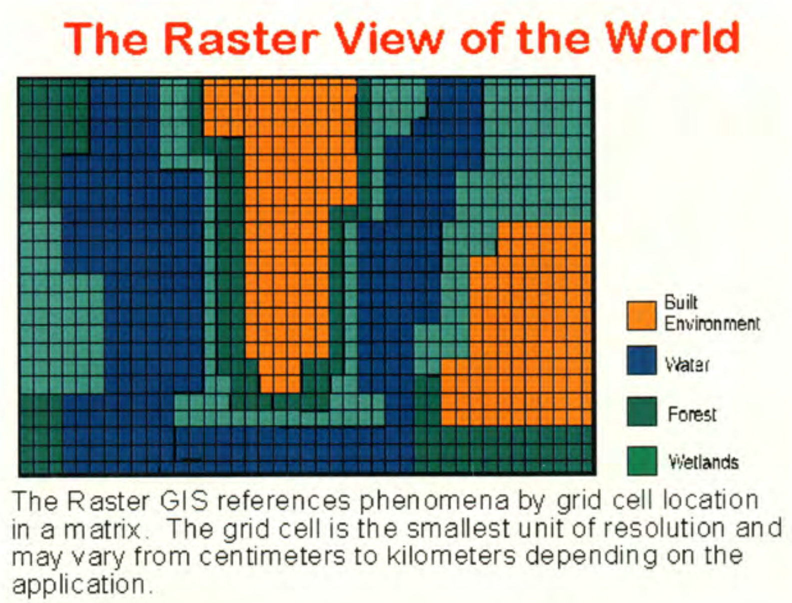

Figure 10. Raster Data Model
(Source: Foote and Huebner 2000)

Links allowed between spatial and attribute databases in turn allow for a series of operations such as search, overlay, and select to be performed (Rhind 1990). Linkages created between spatial and attribute databases allow decision-makers to access location and attribute data simultaneously in order to better replicate the effects of management and policy alternatives.

Choosing vector or raster methods depends on data sources and analysis needs (Rhind 1990). At times, both need to be used. Most GIS software is able to handle both vector and raster formats. The methods used for this thesis take advantage of vector data at first, in order to allow analysis by querying and performing other operations. This vector data is then later converted into several grids in the raster format and used as input into the ArcView GIS (version 3.2) Spatial Analyst's ModelBuilder extension.

ArcView Spatial Analyst allows users to create, query, map, and analyze cell-based raster data and to perform integrated vector-raster analysis (Environmental Systems Research Institute, Inc. 2002a). ArcView Spatial Analyst has the ability to not only work with raster-based data (including the ability to overlay, query, and display multiple raster themes) but also to do integrated raster-vector theme analysis such as aggregating properties of a raster theme based on an overlaid vector theme (Environmental Systems Research Institute, Inc. 2002a).

To conserve environmentally sensitive land and find appropriate locations for open space development, a community must first select natural resource factors (in the form of themes for data analysis) and determine their ranking for criteria options. The ranking of criteria and how that ranking ought to be weighted will vary with each individual community in reference to values and politics present. For example, one community may wish to establish an open space strictly for species habitat purposes (environmental value), while another community may wish to preserve a potential open space area for recreational purposes (social value); in this case, attribute values would, in accordance, be weighted differently. Once factors (or data) are selected, and criteria have been identified, the weighting for each theme may be determined for use in a spatial model. A spatial "demonstration" model was created in this thesis for the purpose of displaying this process of analyzing data.

Demonstration model methods

To reflect weighted differences in criteria, ArcView's version 3.2 Spatial Analyst and ModelBuilder was used in this thesis to create a demonstration model. Using ArcView GIS version 3.2 Spatial Analyst and ModelBuilder extension, the demonstration model allows the user to weight and rank criteria attributes through the assignment of numerical values as scores based upon a community's needs. The use of ModelBuilder also allows the user to keep selected factors (data) in themes and use them in a working model that may be run as often as desired. The steps for the model were the following:

1. Convert data from vector to raster;
2. Score each theme from low to high (from 0 – 1, where a 1 is high);
3. Rank the themes in order of influence based upon community criteria (higher-weighted themes have more influence on the model); and,
4. Use ModelBuilder's arithmetic overlay process to "add" ranked themes together to produce a final map

ArcView's Map Calculator may also be used for the purpose of weighting and ranking, however ModelBuilder is a more user-friendly application (Anderson 2002). Additionally, the ModelBuilder tool allows for the creation of a user-friendly spatial model. Using this tool, factors (as themes) are combined by overlay in the raster environment and then analyzed according to "weighting" of factor importance and quantifying evaluation criteria (Environmental Systems Research Institute, Inc. 2002b). This is referred to as a standard "weighting and rating" suitability modeling technique (Environmental Systems Research Institute, Inc. 2002b). In this technique, individual elements are weighted in order of influence, while scores grade parcels on a constant scale, allowing them to be rated and/or ranked. For example, if in a development situation, the soil quality of a property ownership parcel was considered more important than that parcel's proximity to urban development, soils would thereby hold more weight and have a greater bearing on that parcel's overall score.

Like the example above, the demonstration model used an ownership parcel theme as its base overlay theme. Individual ownership parcels accrued value from the various elements in the model criteria through a "weighting and rating" technique. A weighting and rating technique "can simplify decisions and help make them more rational, [while also] easing decision documentation and facilitating public participation" (Hobbs 1984, 3). The demonstration model analyzed, edited, and integrated natural resource factors allowing them to be weighed according to community "X's" pre-determined needs assessment. The final product of the model resulted in relative scores indicating the potential of each parcel for open space use. Based upon this, planners may use community "X's" criteria to determine which land parcels are suitable for development and which are not.

The methods implemented within the demonstration model in Chapter 4, *Results*, are derived from the methods in a study by the University of Wisconsin-Madison's Land Information and Computer Graphics Facility (2000), which offers a working model created to preserve another type of open space: farmland.

The Land Information and Computer Graphics Facility (2000) prepared land-use planning recommendations for Dane County, Wisconsin using GIS-enhanced methods. In their study using the ModelBuilder methodology, the Land Information and Computer

Graphics Facility (2000) portrayed a differing picture of how much land was considered 'open space and farmland' in Dane County, WI than what had been shown in a 25 year land-use plan conducted by the Dane County Regional Planning Commission (RPC). In essence, the model provided evidence from the County's own databases that countered the RPC's suggestion of almost completely unencumbered open space beyond city boundaries. Furthermore, the GIS-based analysis of land-use classification from tax assessment roles indicated less than 50% of the county was developable farm and open space; in contrast, RPC used data for their land-use plan that showed 85% of the county in this category, based on air photo interpretation. From this, the Facility has been able to assist the County in developing and disseminating land use information; they have guided the County Executive's staff in the analysis, display and dissemination of their own geospatial data, particularly information related to land use, ownership, assessment, and resources. Overall, and as a result of the study, the use of spatial information technologies is increasingly touted by County staff and officials as a key component affecting decision-making in resolving some of the County's vexing land-use issues (Land Information and Computer Graphics Facility 2000).

The demonstration model was comprised of three sub-models (see Figure 11, page 58): the first sub-model was comprised of specific criteria pertaining to community preservation goals relating to environmental values (such as existing vegetation and land habitat potential), the second sub-model was comprised of specific criteria pertaining to varying community preservation goals related to social values (such as recreational purposes and cultural resources), and the third sub-model was comprised of acquisitions threshold criteria in order to provide a community (or community "X", as is the case in the demonstration model) with a final map for decision-making purposes. Acquisitions threshold criteria included such factors as the availability of land (based upon zoning, building footprints, and future land use plans), equity and need (accessibility of individuals to open space based upon population). The composite open space model, the final map produced, (see Figure 19, page 70) displayed a prioritized selection of sites deemed suitable for open spaces based upon the data editing criteria of allocating one acre of open space per 1,000 residents. This criteria, as well as a community's general chosen criteria for open space site selection, will vary politically within communities and be based on the reliance of citizens' needs.

Within the first and second sub-models, two influences were considered which a community commonly references as important and includes when defining and selecting criteria in the establishment of an open space. These influences included the two sustainability principles/pillars of environmental values and social values. Economic values, the third sustainability pillar, are derived from social and environmental values, and therefore were not included as an influence in the model. The introduction of an open space, as discussed in Chapter 2, *Literature Review*, may create economic benefit within a community by raising real estate values, attracting people into a community, and re-vitalizing a downtown district.

The demonstration model, with its three sub-models, was efficient in that data inputs based on environmental and social values were separated into a rating/ranking system. In the demonstration model, numerical weights were assigned through grid cell ratings and based upon community "X's" hypothetical criteria of what natural resource factors were to be exemplified within an established open space area (which were assigned for the demonstration purposes of showing a working model).

The long-term goal of the conceptual planning process model in land-use decision-making incorporated the involvement of citizens. As shown in the conceptual planning process model, residents ought to be fully involved in defining, implementing, and evaluating community open space. The successful involvement of residents in the implementation of a community open space serves as an indicator of sustainability from the social pillar value perspective and relates back to the overall planning process affecting the other pillar values as well.

The inclusion of citizen participation was difficult to adequately address in the demonstration model presented. To compensate for the missing aspect of citizen participation in the demonstration model, a hypothetical selection of criteria was used instead. As useful as this demonstration model may prove to be, it cannot estimate subtle personal and social impacts or project needs. In the future, a GIS-based model (such as the demonstration model presented in this chapter), ought to be used as a tool integrating and weighing public value decisions agreed upon by community members. For this purpose, a needs assessment should be undertaken at the local level in order to determine the detailed needs of a community. Moreover, this may require that the planning community initially help citizen groups become comfortable with GIS technology and provide direction so that a community's "open space model" becomes their own through the weighting and rating of criteria selection.

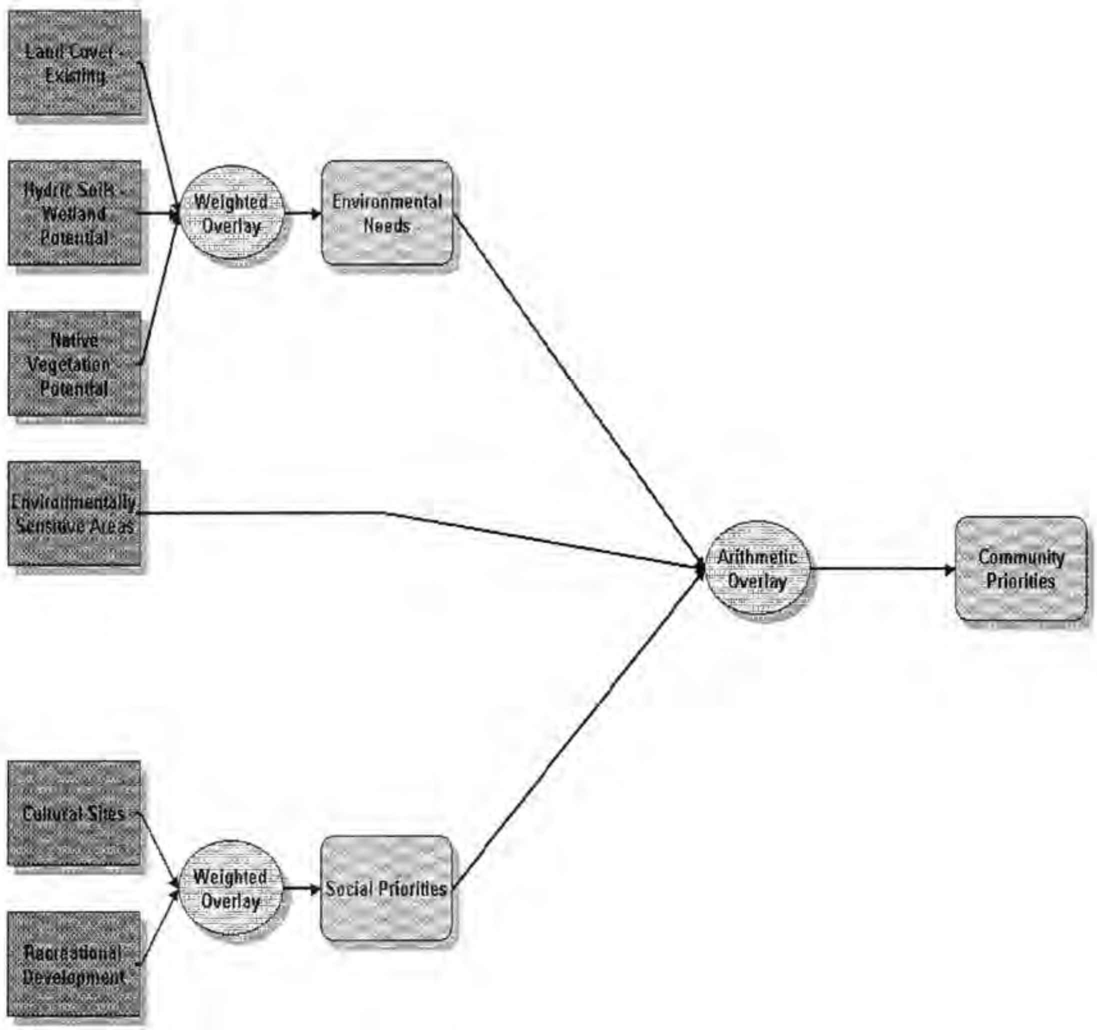

Figure 11. ArcView GIS use of Modelbuilder in the Demonstration Model

To determine the total points assigned to cells of a potential open space, the values for all chosen criteria within each percentage weighted sub-model were added through the process of an arithmetic overlay. The City of Ames had a pre-existing land-use classification determining environmentally sensitive areas in their databased land-use policy map theme layer. To take into account the City's (and thereby community "X's") pre-determined needs assessment of what an environmentally sensitive area was, this theme was used as a constant in the model (see Figure 11, page 58) in addition to projected hypothetical environmental criteria to ensure that the model applied ranking to those geographical areas as well.

The demonstration model was sensitive through the assignment of indicator values (0 – 1; 1 being the highest or the best) as well as percentage score, (0% weights factors as being not important to the community, 100% weights factors as being very important and holding priority within the community) which can be changed within the modular displays. The ModelBuilder dialog boxes allow the users to change criteria selection score and percent. This way, users can replace datasets, change assumptions or model parameters, and consider alternative scenarios in which input factors are weighted differently. After the score of each property/parcel was calculated, all properties/parcels were adequately ranked. Those properties/parcels ranked the highest (i.e. those scoring the highest) may then be knowledgably and appropriately given acquisition priority by a community upon their criteria selection and based upon their needs assessment.

Summary

This chapter elaborated on how to establish sustainable open spaces in the urban pattern by using sustainability principles and GIS, as a functional planning tool, in the planning process. Various planning literature was described in the chapter, highlighting planning process models and presenting a conceptual planning process model for the implementation of open space in a local community.

Also in this chapter was the justification for the prioritization of selected natural feature attributes in order to define and relate the characteristics of an environmentally sensitive area. Described in this discussion was the role of criteria and factor selection for an open space. Selected data, or criteria and factors, ought to be considered on a case-to-case basis, as appropriate to the community for which the open space is intended to function.

A discussion of GIS technology and its use in the planning process was defined. GIS, with its mapping capabilities and allowance for data input, provides a process in which planners can use a method for evaluating potential land acquisitions for the establishment of an open space. In this thesis, GIS was chosen as a strategic planning tool and as a means to implement solutions within the planning process. In Chapter 4, *Results,* a demonstration model uses GIS and its applications as a planning tool. Used as a planning tool, GIS improves the availability, resources, and quality in which information and data are displayed, allowing communities to make more informed decisions when developing land-use plans. Planners, among others, may use GIS technology and data to efficiently analyze management and policy issues in order to better the land-use decisions of local communities.

CHAPTER 4. RESULTS

In this chapter, a demonstration model, exhibited as a "walk-through" example, displays the prioritization of open space criteria through a weighting and rating method discussed in Chapter Three. Research methods defined in Chapter Three approached how to implement sustainable open spaces in a community using GIS, and more specifically ArcView GIS version 3.2, as a planning tool and as a means to implement solutions within the planning process. Through mapping effects using GIS applications, the demonstration model displays the value and importance of land-use maps as visual aid tools, influencing local decision-making and the implementation of sustainable open spaces for the benefit of the public good. The implementation and use of GIS as a planning tool, and as used in the demonstration model, may aid a community in selecting the most beneficial land to preserve for the purposes of establishing a sustainable open space. Toward its conclusion, this chapter briefly reflects on other existing software technologies that may beneficially serve as resourceful planning tools.

The basis for the creation of a demonstration model for this thesis, similar to the conceptual open space planning process model, was in GIS literature and method examples. As mentioned in Chapter 3, *Methods*, the demonstration model methods were derived from the study by the University of Wisconsin-Madison's Land Information and Computer Graphics Facility (2000). In contrast to the demonstration model contained within this chapter, the Facility's study offered a working model created to preserve another type of open space: farmland. To provide for a visual example and scenario of how the demonstration model works, a community and hypothetical situation are presented. Using only some of the recommended open space criteria for the hypothetical situation, the demonstration model contains a limited data set. It should be emphasized that the purpose of the demonstration model is to serve as an example only. The user will need to modify his/her assessment of the model in order to make his/her own data work. It ought to be acknowledged that if a limited database is used and/or if limited data is collected, the use of GIS as an analytical tool will be limited as well.

Study area

The study area used to demonstrate the model is within Story County, located in central Iowa, and focused on the City of Ames (see Figure 12).

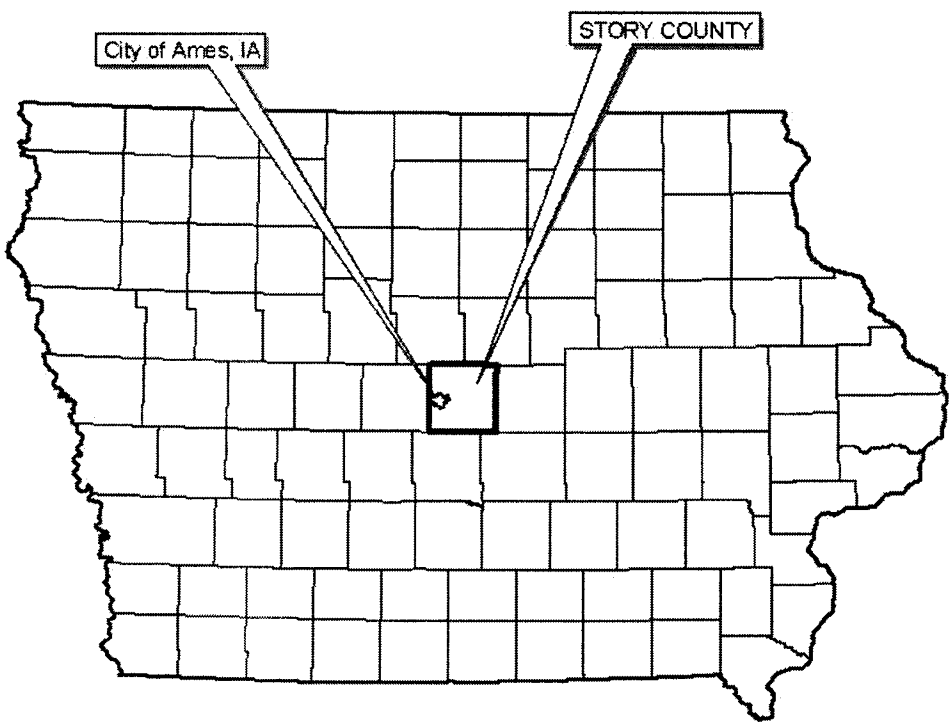

Figure 12: Location of Ames, Iowa and Story County, Iowa

The boundaries of Story County were established in 1846. The county was named after Joseph Story, a preeminent United States Supreme Court Justice, in 1853 (Story County, Iowa 2002). Railroad construction largely aided in the development of Story County. Although Nevada (the County seat) was the early population center of the county, Ames was the most widely known of the towns because of the busy railroad depot where travelers changed trains for all points north, south, east and west. Today, Story County has an area of 576 square miles and consists of 16 townships and 15 incorporated cities (Story County, Iowa 2002). The population of Story County's 2000 census was 79,981; the recorded population for the City of Ames in 2000 was 50,731 (including the student population at Iowa State University).

Story County, Iowa, originally existed as prairie with the exception of some groves along the larger streams in the area. "Ames sits on a landscape that was covered by a glacial ice sheet 14,000 to 12,000 years ago (the Des Moines Lobe) which receded 12,000 to 11,000 years ago (Prior 1991); the soils are some of the most fertile in the world and consequently almost all of the surrounding land has been converted to cropfield" (Norris and Farrar 1998, 49). Today, Ames currently includes 33 parks and woodland/open spaces totaling 759 acres maintained by the Ames Parks and Recreation Department (City of Ames, Iowa 1996-2002).

Geographic Information System (GIS) Application: A Model Example

Suppose that in the community of Ames, Iowa (referred to from this point as community "X", as the model represents a fictitious scenario), is amending their zoning and land-use maps for their comprehensive plan and wish to plan for the future setting aside of environmentally sensitive land for the purpose of preserving land areas as open spaces. Community "X" has been through this process in the past and has been successful at preserving environmentally sensitive land as classified on their already existing land-use policy plan. However, the community has experienced a considerable growth in population that has largely contributed to sprawl. Through a needs-based assessment survey distributed, collected, and analyzed by the city planner, citizens in community "X" have expressed their interests and opinions in response to sprawl. Consensus from the survey revealed a common desire among citizens to place more emphasis on a particular selection of natural resource factors that they felt ought to be incorporated as criteria for land classified as environmentally sensitive. Natural resource factors, as selected by citizens to be incorporated as criteria, were wetlands and native-vegetation areas. Using this information, the planner has chosen to use ModelBuilder in order to produce land-use scenarios offering solutions of where to establish future open spaces and thus, environmentally sensitive classifications of land. Specifically, the planner, with community "X's" input, is striving to create a mitigated wetland site for the purpose of establishing a sustainable open space within the community.

To re-cap, the demonstration model, using ModelBuilder, operates was through the assignment of indicator values (0 – 1; 1 being the highest or the best) as well as percentage score, (0% weights factors as being not important to the community, 100% weights factors as being very important and holding priority within the community). This model is sensitive to criteria and able to produce various scenarios in that indicator values and percentage scores can be changed within the modular displays.

Referring back to demonstration model methods established in Chapter Three (see Figure 11, page 58), environmental needs (sub-model 1) have been set at a 75% importance level that a site location be comprised of hydric (wet) soils criteria, and at a 25% importance level that a potential open space's site location criteria consist of native vegetation in the form of prairie. This information/criteria selection is then entered into ModelBuilder's display (see Figure 13, page 65) where the following scores apply:

Lndcov

(Existing Vegetation)

1 = forest/wetland
2 = wetland
3 = prairie

Natveg_grd1

(Native Vegetation)

1 = prairie
2 = forest

Wetlnd_slsgrd1

(Soil)

0 = not a hydric soil
1= this is a hydric soil

Input Theme	% Inf	Input Field	Input Label	Scale Value
Lndcov	0	Value		
		0	0	0
		1	1	0
		2	2	0
		3	3	0
		NODATA	No Data	Restricted
Natveg_grd1	25	Value		
		0	0	0
		1	1	1
		2	2	0
		NODATA	No Data	Restricted
Wtlnd_slsgrd1	75	Value		
		0	0	0
		1	1	1
		NODATA	No Data	Restricted

Figure 13: Community "X's" Environmental Criteria Weighting

This example environmental criteria weighting then produces the map shown in Figure 14 (see page 66). The dark(er) areas in Figure 14 represent those areas with the highest score based upon community "X's" environmental criteria.

Also, in the needs-based assessment survey, citizens of community "X" indicated a desire for certain social needs and wants to be included in proposed open space areas allocated for environmentally sensitive land-use purposes. This value was been included and incorporated into the demonstration model (see Figure 11, page 58) as "social priorities" so that it could be ranked in the selection of sites also.

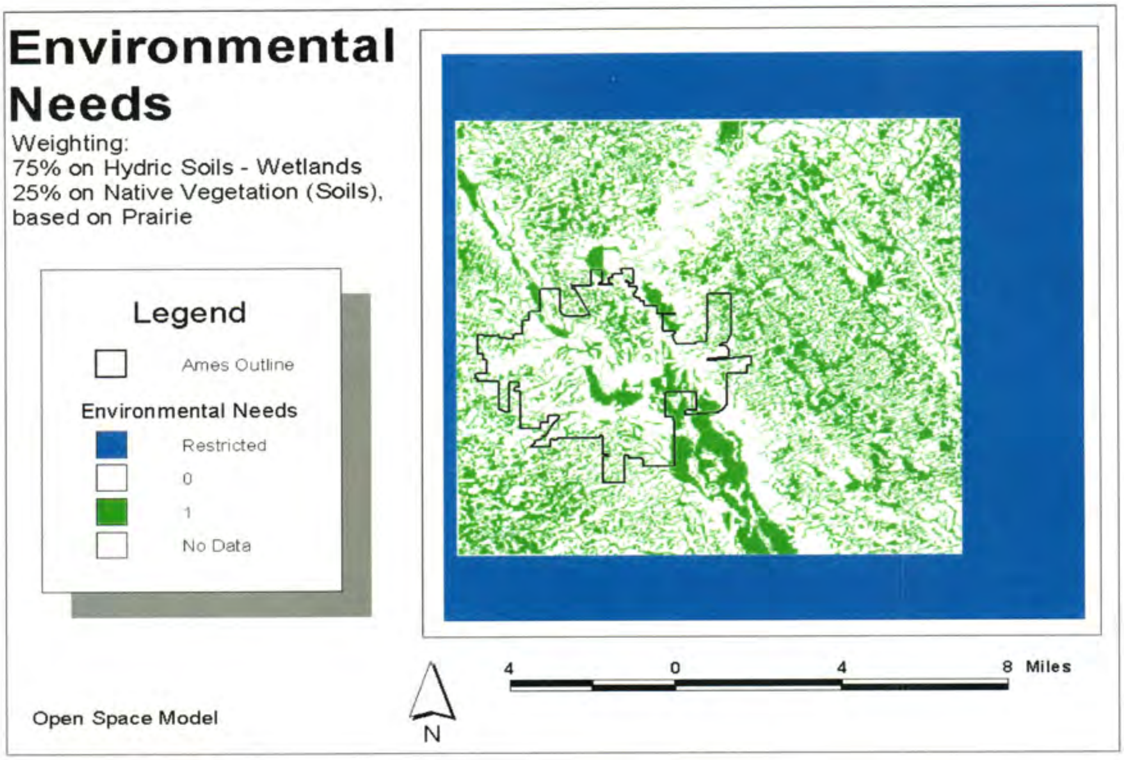

Figure 14: Sub-Model 1 – Environmental Needs Map

For this hypothetical situation, suppose that recreational needs are a high priority in the community, and community "X" desires to potentially acquisition only those areas chosen from sub-model 1 (environmental needs) that are able to meet that contain three out of the following four recreational opportunities: picnic areas, paths and trails, campgrounds, and playgrounds/ropes course. This information/criteria selection is then entered into ModelBuilder's display for sub-model 2 (see Figure 15, page 67) where the following scores/ranking applies:

Arcsites_grd

(Archaeological/Cultural resources located within Township, Range, and Section - TRS)

0 = TRS does not contain any sites
1 = TRS represents a site, or a number of sites

Recdev_slsgrd1

(Recreational Development Opportunities)

1 = Contains 1 of 4
2 = Contains 2 of 4
3 = Contains 3 of 4
4 = Contains 4 of 4

Input Theme	% Inf	Input Field	Input Label	Scale Value
Arcsites_grd	0	Value		
		0	0	0
		1	1	0
		NODATA	No Data	Restricted
Recdev_slsgrd1	100	Value		
		0	0	0
		1	1	0
		2	2	0
		3	3	1
		4	4	1
		NODATA	No Data	Restricted

Figure 15: Community "X's" Social Criteria Weighting

The model is set-up so that, had community "X" prioritized their open space selection criteria to include archaeological/cultural resources, this need would have been satisfactorily met, as distinguished within the model. This example social criteria weighting produces the map shown in Figure 16 (see page 68). The dark(er) areas in Figure 16 represent those areas with the highest score based upon community "X's" social criteria.

The next step for community "X", following the model (see Figure 11, page 58), is to arithmetically add sub-model 1 (environmental criteria) with sub-model 2 (social criteria) to produce for a final map portraying the community's chosen environmental and social criteria for an open space (see Figure 16, page 68). Imperatively, the arithmetic equation for the model also includes community “X’s” land-use classification of “environmentally sensitive areas” (based upon community “X’s” data-based land-use policy plan).

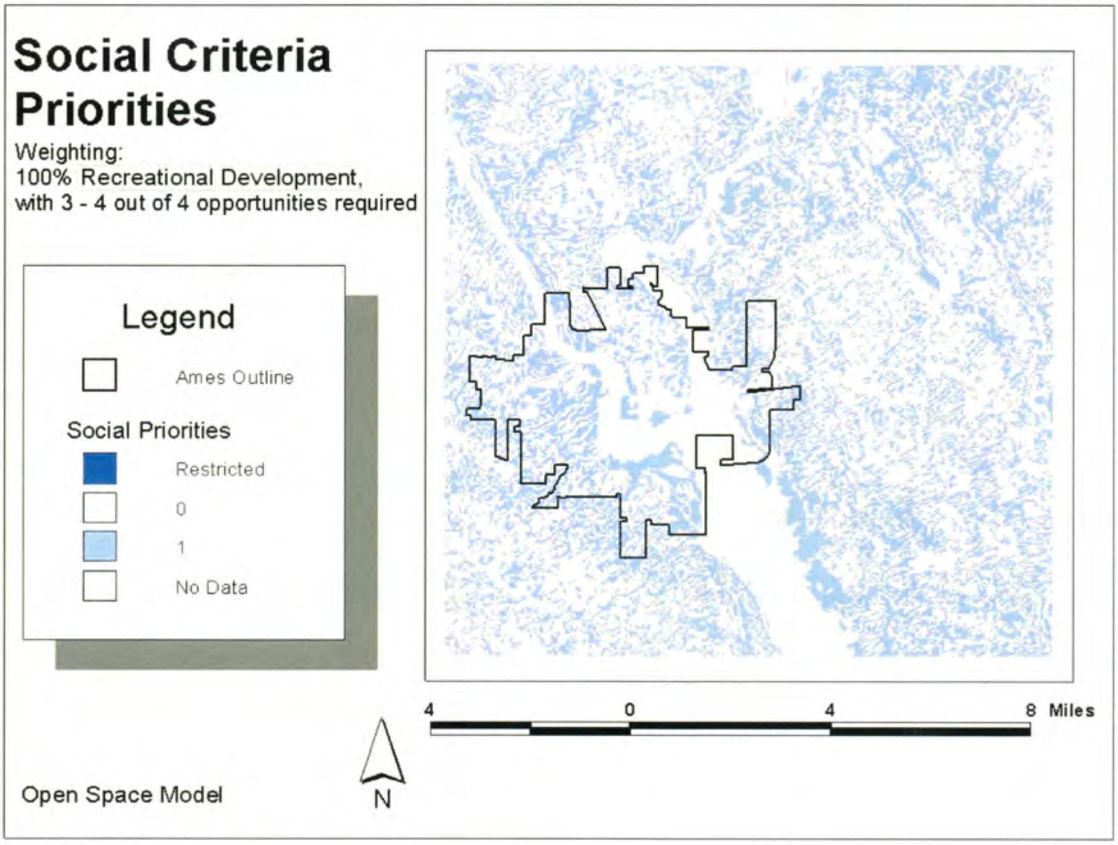

Figure 16: Sub-Model 2 – Social Needs Map

This previously existent theme layer serves as the constant of this demonstration model for the purpose of representing and respecting those land areas that were already selected as environmentally sensitive areas and potential sustainable open spaces. The mathematical equation, in its entirety, is simplified as the following: Environmental Needs + Social Priorities + Environmentally Sensitive Areas (the constant) = *Community Priorities* (or in this case, a newly created theme).

Input Theme	Op	Multiplier	Input Field	Label	Value
Environmental Needs	+	1	Value		
			-1	Restricted	-1
			0	0	0
			1	1	1
			NODATA	No Data	0
Social Priorities	+	1	Value		
			-1	Restricted	-1
			0	0	0
			1	1	1
			NODATA	No Data	0
Envriiv	+	1	Value		

Figure 17: Arithmetic Overlay of Community "X" Example

The produced community priorities theme created from the arithmetic overlay process appears as the visual map shown in Figure 18 (see page 70). The dark(er) areas in Figure 18 represent those areas with the highest score based on the environmentally sensitive areas constant added with community "X's" environmental and social criteria.

As a reality check for community "X" of the demonstration model's effectiveness, the northern-most dark red area displayed at the top of the Ames outline in Figure 18 (see page 70) is actually a site location that is currently being developed as a recreational area and nature preserve. This site, temporarily called Ames Quarry, combines the protection of the Ames water supply with the development of a large open space/recreation area with native plant communities. The decision-making of the use of the Quarry involved Story County residents, professional consultants (ranging from engineers to geologists and environmentalists), Ames City planners, and Ames elected officials. GIS technology was also involved in the Quarry decision-making process, as it was actively used to translate data and define land-use problems surrounding the area. The Ames Quarry site combines the natural resource factors of prairie, wetland, and woodland habitat, as well as the potential to provide an attractive recreational area.

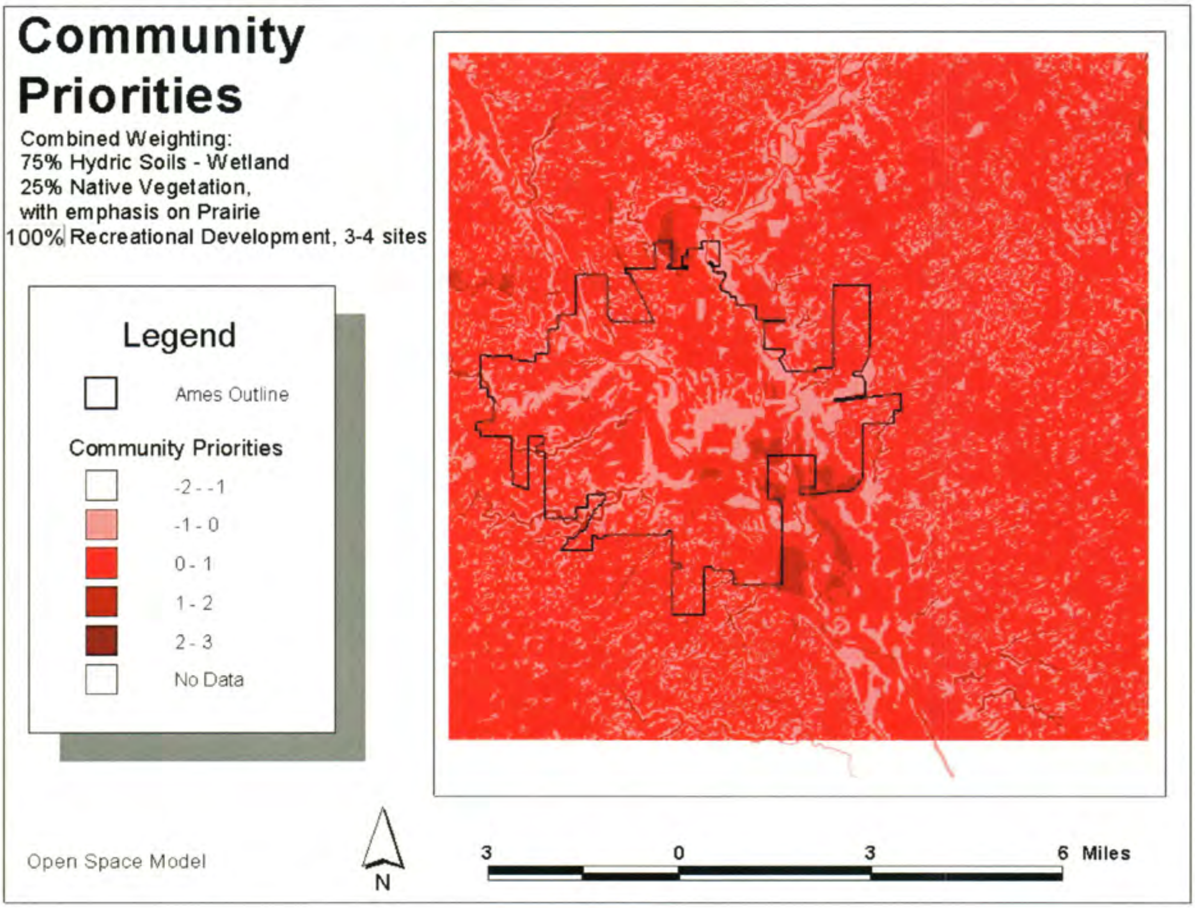

Figure 18: Community "X's" Community Priorities Map

Community "X's" hypothetical factor criteria was very similar to those factors present at the Ames Quarry site location. The demonstration model's ability to select the Ames Quarry conveys that this model was effective.

The third sub-model of the demonstration model (see Figure 11, page 58) was comprised of acquisition threshold criteria, which will vary from community to community (see Appendix A for data input references). The inclusion of this sub-model into the demonstration model presents an informative visual map with additional themes and their data.

The map presented in Figure 19 displays community "X's" prioritized areas (shown in dark red/purple) offered as environmentally sensitive site location solutions and potential locations for open space from Figure 19 based upon cost, availability, zoning, population (equity), roads (accessibility), the current Land Use Policy Plan, and existing buildings and parks. In the case of community "X", the darker selected sites from Figure 19 have been edited and displayed in ownership parcel acreages for acquisition decision-making purposes. This was done because plots of land are most commonly marketed and sold as parcels.

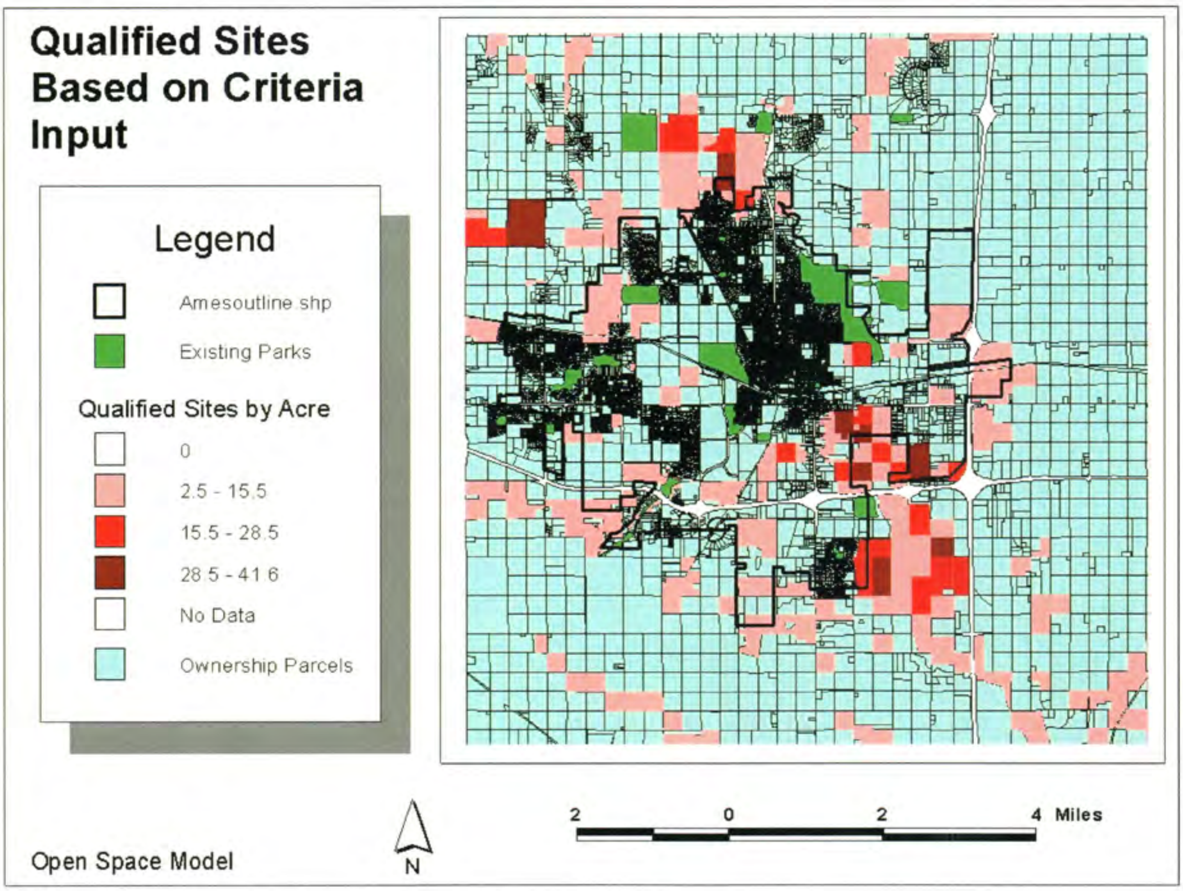

Figure 19: Composite Open Space Model

At this point in the conceptual planning process model (see Figure 5, page 38), the planner would most likely present the visually mapped solutions for site selection in Figure 19 (see page 71) to community "X" and work with its citizens to decide upon and identify one common solution (or site) and then begin planning how to act on that solution, and in this case acquire the chosen parcel of land. Based upon what solution, or parcel of land was chosen and prioritized for a mitigated wetland site with recreational opportunities, it would be up to the planner and community "X" to further investigate options into whether that parcel or of land was available for acquisition. Refer to Chapter 5, *Implementation*, regarding concepts of how to acquire, fund, and protect sustainable open space areas. For the purpose of implementing a <u>sustainable</u> open space, the planner and community "X" would need to determine whether or not the chosen parcel of environmentally sensitive land and its site location was capable of meeting the sustainability principles discussed in Chapter 2, *Literature Review.* Landscape ecology principles (also discussed in Chapter 2), may aid in determining sustainability by measuring a selected site's connectivity.

GIS capabilities and limitations within the demonstration model

When a question or issue addresses spatial phenomena, such as where environmentally sensitive areas exist within a community and/or where an open space could be established, a GIS may be used to develop a model that will evaluate analytical procedures, obtain new information, and investigate results. The use of GIS as a means to determine solutions in the context of the conceptual open space planning process model (see Figure 5, page 38) allows for the mapping of natural resource qualities in order to locate sites. As part of the planning process, the use of a GIS allows for the analysis of a community's selected criteria and represents that community's needs. The demonstration model offers a technique that allows a community to prioritize land-use using a GIS based upon values and weights assigned to natural resource factors. Beyond simply mapping the locations of features and creating for an optimal location for open spaces, the methods of the model and use of GIS technology for analysis offers additional levels of information.

As displayed in the model, the accuracy of available data is an important aspect to take into account. Prioritizing land-use for an open space using a GIS model is a data-driven process. The accessibility of data and how data is formatted may potentially create for biased results. The analysis, as conducted in the demonstration model, uses only existing data that could be derived quickly from accessible coverages. These data do not necessarily account for all of the resources that should be considered when evaluating land for preservation purposes. For example, some of the data sets used in the demonstration model, such as the wetlands data set, do a good job in denoting where wetlands do or do not exist. Meanwhile, other data sets, such as a land-use theme, may not do a very good job in reflecting spatial distribution as it is often changing and needing to be updated. For this purpose, it is important to collaborate with a community, intergovernmental staff, and citizen participants regarding what land-use questions need to be answered, and how a GIS (using available data) may be used to create for a model that will best answer those questions. Moreover, future land-use, with all of its factors involved, requires case-by-case decisions that will have to be made by a community for that community.

The demonstration model's main limitation, as related to the general technology of GIS, is its ability to account for human error in data editing. The possibilities of human error when editing data using a GIS stress the importance of the demonstration model to be accompanied and included as part of the conceptual open space planning process described in Chapter Three. "The details of constructing [a sustainable open space] – the application of concepts – are guided and frameworked by the details of the site, its ecology, and its society" (Janzen 1998, 1313).

The publication of GIS Metadata may decrease this possibility of human error. Metadata may aid a user in determining the application of data as it is displayed in maps by informing what data was designed to do (Oklahoma Center for Geospatial Information 2003). Metadata provides documentation of data source themes and essentially serves as the "nutritional label" for GIS datasets (Federal Geographic Data Committee 2003). In a standard format, metadata documents the characteristics of data so that consumers may determine the data's fitness for their purpose (Federal Geographic Data Committee 2003). Metadata, as linked to map images, allows a user to understand relevant spatial data.

The demonstration model displays an example of how to use GIS to create a model for the purpose of determining solutions. In this thesis, the use of GIS was integrated into the conceptual open space planning process model as a means to determine solutions. In this context, the use of GIS may serve as a key tool in the planning process, yet it still exists in the overall model as only part of one of four phases. Therefore, in order to function appropriately and create for a successful open space project, the demonstration model must be accompanied by the other processes and phases of the conceptual open space planning process model.

Beyond GIS: Additional Tools for Open Space Allocation

The application of ArcView GIS version 3.2 and Spatial Analyst's ModelBuilder extension is an example of one of the appropriate tools available for use in planning that allow for the weighting and balancing of environmental concerns, and to be used for the purpose of open space establishment and allocation. This section looks at some of the other existing tools that aid in allocating open spaces within communities.

The Land Evaluation Site Assessment system

Land Evaluation and Site Assessment (LESA), by ranking criteria and assigning scores to parcels, is another planning tool that may be used for open space protection while aiding the containment of urban sprawl and directing growth towards an orderly outward movement (Schoon 1991). "With LESA, community development would emphasize the protection of traditional rural industries of farming, forestry, and mining, as well as encourage more compact, orderly growth so sufficient services can be provided; LESA can then, obviously, be used to protect the best interests of both the city and the countryside" (Schoon 1991, 31). The LESA system was created in 1981 by the U.S. Soil Conservation Service, in response to the needed improvement of the standard soil surveys that were being conducted in the late 1970's and 1980's. LESA was designed in an attempt to "provide enough information to meet public policy needs regarding issues of farmland conversion and farmland protection" (Steiner 1994, 14). LESA was developed to aid communities in the task of sorting through the complex issues surrounding farmland preservation by assigning "weights" and scores to farmland. Although the LESA system was developed at the federal level, it was intended to be adopted mostly at the local level. The LESA system is a comprehensive planning tool for not only planners, but for local city officials, soil conservationists, farmers, and citizens to rate a tract of land's soil potential for agriculture, as well as social and economic factors, such as location, access to market, and adjacent land use (Steiner 1994, 13).

One drawback of the LESA system is its complexity; it is more organized for use by professionals and is less user-friendly for interested citizens to perform. Another drawback of many LESA systems, as developed by the United States Department of Agriculture (USDA) and because they have been implemented many different ways, is that they lack an appropriate weighting measure regarding open space benefits of preserving natural and environmentally sensitive areas. One suggestion to address this drawback is to combine the LESA system with GIS to create a viable system addressing environmental concerns in addition to those concerns of agricultural land preservation.

Rapid Site Assessment

Rapid Site Assessment is another tool that can be used for open space allocation. Rapid Site Assessment techniques are based on long established principles in planning, landscape architecture, and soil science (Lucht and Joubert 2002). This technique takes advantage of information sources that have become more widely available over the last several years due to the evolution and availability of digital GIS technology and data. The analysis is divided into two levels. Level one uses a simple photocopy of a plat, United States Geological Survey (USGS) topographic map, and a series of resource maps available via the Internet. Level one is user-friendly to those individuals with limited information or no GIS experience. Level two caters more to professional planners or engineering firms as it contains a more advanced analysis requiring a moderate to high skill level. Rapid Site Assessment includes the following benefits (Lucht and Joubert 2002):

- Aids in identifying community-wide protection priorities using planning-level information and town plan goals;
- Identifies general site suitability for development. Identifies areas with severe development constraints where construction costs are higher as well as sensitive areas where disturbance should be minimized to reduce environmental impact; and,
- Provides a clear understanding of constraints and opportunities in user-friendly, visual format as a basis for reaching an agreement of preferred options.

Some of the problems and limitations that occur with the Rapid Assessment process involve a lack of consistency among town requirements/subdivision ordinances, making it more difficult for developers and engineers to know what to expect. Additionally, not all applicants have the same resources, creating disparity in how different projects are to be reviewed. More intensive review procedures are necessary for more sensitive lands; incomplete applications create regular problems for reviewers, who frequently do not receive information soon enough to thoroughly assess a site early in the process, when changes are less expensive to make (Lucht and Joubert 2002). The Rapid Site Assessment technique is useful in any project review, but proves especially valuable for compact designs such as cluster zoning and conservation development (Lucht and Joubert 2002).

Green-space Acquisition and Ranking Program study

Another appropriate tool in planning for open spaces may exist in a variation of the methods used in the Green-space Acquisition and Ranking Program (GARP) study (Thrall, Swanson, and Nozzi 1988). GARP is a computer-assisted decision strategy (CADS) that may serve as the basis of an orderly and rational local government program of acquiring land for open space and recreation (Thrall, Swanson, and Nozzi 1988). This study addresses the acquisition and ranking of green spaces specifically relating to citizen's determination and ranking of criterion, and offers another perspective regarding how to proceed with addressing a community's natural resource needs.

Goals of the GARP study involved the creation of an objective strategy for the ranking of parcels of land for public acquisition. The system created as a result of the study, is designed to minimize shortsighted, politically motivated land acquisition decisions, and instead, facilitate long-range decision making in the public interest.

GARP is composed of a set of criteria that program users apply to each prospective parcel of land. The criteria are comprehensive but sufficiently general to allow GARP to be applied in most geographic regions. Fifteen criteria are used to rank parcels. These criteria are designed to assess the following (Thrall, Swanson, and Nozzi 1988):

1. The population density or degree of development near the parcel;
2. The proximity of the parcel to existing public parks;
3. The capacity of the parcel to offer public access to a natural resource;
4. The degree to which the parcel is serviced by an existing or potential recreational trail;
5. The usefulness of the parcel as a component in a greenbelt system;
6. The usefulness of the parcel in connecting existing public parcels or extending a public parcel;
7. The usefulness of the parcel in supporting multiple recreation and conservation purposes;
8. The uniqueness of environmental, geological, or historical attributes at the parcel;
9. The diversity of environmental, geological, or historical attributes at the parcel;
10. The importance of the parcel in preserving the integrity of an ecosystem;
11. The cost to acquire or manage the parcel;
12. The willingness of the parcel owner to negotiate for public access, acquisition, or management;
13. The degree of development pressure applying the parcel;
14. The jurisdiction that the municipality would have over the parcel; and
15. The deleterious effect that capital intensive development for active recreation use will have upon the passive (important environmental) use because of the interdependence between the two.

Numerical values are then assigned according to how well the parcel conforms to each criterion and the importance of the criterion for "active" and for "passive" recreational use. “Active” use is categorized as requiring capital-intensive development, such as ball-playing fields (Thrall, Swanson, and Nozzi 1988). “Passive” use is considered typically low intensity, such as bridle and walking paths (Thrall, Swanson, and Nozzi 1988). Numerical values for each parcel are summed separately for active and for passive use; these resulting scores reveal an ordinal ranking of the properties for each of the two uses.

GARP's final form was designed to be understandable to politicians, non-elected community leaders, news reporters, administrative heads of various governmental agencies, and to citizens. Criteria used to rank parcels were made to be sufficiently clear so that a layman could understand the mechanisms that drove GARP. A drawback of GARP is that ranking parcels purely on the basis of their environmental importance requires an intensive time-consuming evaluation of the specific parcel as well as the regional environment (Thrall, Swanson, and Nozzi 1988).

<u>Summary</u>

Within the demonstration model, use of a GIS served as a method for identifying and prioritizing suitable sites for establishing open spaces. The demonstration model, as illustrated in this chapter, exhibited the benefit of using GIS technology for use as a mapping tool, and as a planning tool for implementation strategy. The creation of maps using GIS may aid and influence local government decision-making. Through use of GIS models, county and city planners, as well as other users, are able to generate land-use scenario maps that aid in the identification of where development ought to occur in order to better conserve valuable environmentally sensitive resources and natural resource factors as selected for the overall preservation and establishment of open space. The analysis and land-use recommendations conducted and produced using the demonstration model may be used to identify areas for protection/preservation in terms of environmentally sensitive/natural resource areas, and to provide overview information regarding land and its attributes.

The model was limited to available data in the form of GIS themes and selected criteria used for input into the model, and the possibility of human error in data editing. Before modeling begins, a large amount of data needs to be gathered and derived;

fortunately, GIS organizations in the State of Iowa are generous about sharing GIS data. A large portion of work for this project was spent on the creation of a demonstration model that allowed for a sensitive weighting of criteria. The demonstration model, as a method of analysis, strategically determined how sustainable open spaces may be adequately preserved and planned for using ArcView GIS version 3.2 and Spatial Analyst's ModelBuilder extension. Use of the ModelBuilder extension achieved an effective method approach through its ability to be easily altered by the user when weighting and ranking data. Moreover, the ModelBuilder extension, as it operates within ArcView GIS version 3.2, offers a user-friendly interface design. The demonstration model, as proven through a reality check, provides an efficient model and working example for communities and planning professionals to follow.

CHAPTER 5. IMPLEMENTATION

Planning for a sustainable open space requires the acquisition and designation of one main ingredient -- land. After an environmentally sensitive parcel of land has been delineated and selected as a desirable location for a sustainable open space (using a GIS or other methods), the next phase in the planning process is to determine how the open space is to be acquired, funded, and implemented within a community. This chapter refers to the decision-making phase of the conceptual open space planning process (PHASE III) through a discussion of funding options available to aid in the acquisition (transfer of land ownership) of land for sustainable open spaces.

Recommendations made in this chapter also relate to the demonstration model (see Chapter 4, *Results*) by offering and providing direction to a community. These recommendations are to be considered <u>after</u> an open space suitability analysis based upon criteria needs and factor selection has been conducted. Included in this chapter are suggestions regarding applications that a community may use to implement a sustainable open space.

<u>Preservation Techniques of Sustainable Open Spaces</u>

Preservation techniques of sustainable open spaces addressed in this thesis include the following: zoning and the use of maps; subdivision ordinances; acquisition; public means of acquiring open space; and private means of acquiring open space.

Zoning

Regulatory zoning is one of the primary means employed to preserve existing land features and land for sustainable open spaces within urban areas. The U.S. Supreme Court has upheld the legality of local zoning powers since the *Village of Euclid et al. v. Ambler Realty Company* decision of 1926. Since that time, states throughout the U.S. have authorized counties and/or municipalities to zone. Zoning allows for the division of a community into districts, and to define those districts by use and intensity (Kelly and Becker 2000). In relation to open space, the regulatory device of zoning ensures that development is directed away from environmentally sensitive areas, existing land uses are shielded from incompatible land uses, and that future land use patterns incorporated into the comprehensive plan are achieved (Hoch, Dalton, and So 2000). City zoning regulations act as implementation tools within the comprehensive plan and are able to offer more specific guidance in terms of land use (Kelly and Becker 2000). More importantly, zoning has been used to preserve the social composition of suburban communities by regulating the uses of land within their jurisdiction to exclude "undesirable" uses (Mattson 2002, 10-11).

A common legal device used to carry out local zoning is to include a written zoning ordinance within a community's adopted comprehensive plan (Hoch, Dalton, and So 2000). Zoning ordinances and subdivision regulations are the two most common legal devices used to carry out an adopted comprehensive plan (Hoch, Dalton, and So 2000, 343). "Once a town council adopts [zoning] maps and codes, [the zoning ordinance] becomes a judicial policy instrument" (Mattson 2002, 10-11). Unfortunately, zoning laws can be changed and are particularly vulnerable to pressure groups having special interests (Shomon 1971). Therefore, zoning laws ought to be based on long-range needs and should not be changed until all public and private interests are made aware of and approve of what the land-use change will mean in terms of possible effects on the total environment (Shomon 1971). What is known legally as an official map, or a zoning map, is often included in a comprehensive plan as a control mechanism to guide development.

The use of maps in zoning

Included often as an adjacent component of the zoning ordinance or comprehensive plan, the zoning map is an official document that may take the form of a single sheet, a series of indexed sheets, or an atlas (Hoch, Dalton, and So 2000). "Many zoning maps are now computerized, appearing as overlays on a base map, and can be easily updated as boundaries and property lines change" (Hoch, Dalton, and So 2000, 348-9). A zoning map can be used to outline open space areas that are to remain protected in a community. The planning commission holds the power of recommending the original zoning map to the governing body, "which then adopts the map as part of the zoning ordinance, or local law; changes to the map require review and recommendation by the planning commission as well as by the governing body" (Kelly and Becker 2001, 214).

Arendt (1999) writes of base maps showing fundamental site information (such as topography, floodplain, and wetland boundary factors) as being required components in the subdivision review process in order to establish development guidelines:

> In recent years several municipalities have substantially expanded the list of features to include many resources identified in their open space plans. The new kind of base map that has emerged from this evolution identifies, locates, and describes noteworthy features to be designed around through sensitive subdivision layouts. These resources include many otherwise "buildable" areas, such as certain vegetation features; farmland soils rated prime or of statewide importance; natural areas that support native flora or fauna known to be threatened or endangered; unique or special wildlife habitats; historic or cultural features; unusual geologic formations; and scenic views from a property (Arendt 1999, 147).

Arendt (1999) offers model ordinance language for conservation subdivisions in his book, *Growing Greener*. His book provides a good example and reference for local officials and citizens of how to include written language text within a comprehensive plan using certain phrases and citations in order to achieve the end result of protecting and/or preserving open space areas within a community.

As described in the demonstration model (see Chapter 4, *Results*), maps may be used as visual aid tools and for informational purposes in order to relate a detailed point or show descriptive land-use change. In a very honest, but politically incorrect way, author Mark Monmonier (1996) suggests that maps can be used to sway public opinion in favor of land-use proposals, such as the site location of an open space. A large part of implementing sustainable open spaces is working with (or swaying, if you will) the decisions of public citizens. Citizens' votes are often the final decision-maker in passing a budgetary referendum allowing a community to incur debt or use existing funds to incorporate a sustainable open space. While it may seem quite humorous, Monmonier realistically and adequately describes how maps are informative, while also deceptive, and even threatening. This kind of knowledge may be used to the advantage of a community, by not only informing the public, but also advocating for the cause of creating an open space through the data editing of maps. Although not all GIS generated maps are used in this way, this demonstrates a potential problem to be aware of within and/or during the planning process.

In relation to data display, Monmonier's "lying with maps" correlates with Janzen's ideas in Chapter 4 regarding the "distribution of truth with science". Influencing data to produce a certain mapped result could result in swaying the public to make a decision to fund or vote for a recommended land-use change. Metadata, as discussed in Chapter 4, may provide some truth in mapping and data editing. It may seem like a sad strategy to attempt to sway the public, but "lying with maps" to (as an example) exaggerate projected growth in a community versus adequate future open space for that growth, serves as an implementation tactic used to establish sustainable open spaces in communities today and thus ensure their protection for future generations.

Subdivision Ordinances

In contrast to zoning, subdivision ordinances provide for less land-use control regulating, or governing, over how subdivision land is to be developed. Subdivision regulations describe the procedures that a subdivider must follow to obtain approval by a local government, the criteria for the internal design of a subdivision, and construction standards for public improvements in the subdivision (Hoch, Dalton, and So 2000). State enabling legislation awards local governments with the decision-making ability to approve or disapprove development based upon previously set and voted on development standards allotted for in individual subdivision regulations. For comparison purposes, Mattson (2002) elaborated on the contrasting difference between zoning and subdivision code language:

> Subdivision codes are tied to the legal process "of dividing land into smaller units called 'lots' for future sales and development" (Daniels, Keller, and Lapping 1995, 194). It bestows legal ownership standards upon the purchaser and ensure that existing design standards are compatible. A subdivision code provides an opportunity for the community to assure that safe and convenient circulation traffic patterns, and the proper facility capacity of water, sewer and storm drainage exists (Mattson 2002, 11).

Overall, zoning and subdivision ordinances allow local governments the organization and power to appropriately and effectively carry out control over land use in a designated area. These two devices, used to their full effect, help to protect the health and safety of citizens in a community while also acting as tools aiding the preservation of sustainable open spaces.

Acquisition

A main limitation of zoning techniques and subdivision ordinances is that they are prone to legal, economic or political pressures. Outside of zoning and subdivision ordinances, acquiring the title to land may be an attractive option to a community attempting to preserve open space. Most open space purchases of land are acquired in fee simple (full ownership); less than fee interests in land refer to government entities that may have decided that full ownership is too expensive and unnecessary. The issue and process of acquisition requires a source of funding, which requires the use of citizens and consensus groups to vote on issues pertaining to the acquisition of land. The role of consensus in the acquisition of land is critical. In consensus building it is a group that, collectively, absorbs and evaluates information and produces basic elements and concepts of a plan (Innes 1996). "Consensus building is a collective search for common ground and the opportunities for mutual benefit" (Innes 1996, 463).

Often times, the acquisition and preservation of a sustainable open space may require a community to incur debt in order to gain full ownership and protect that land from being zoned or used for other purposes. A common process is for a community to vote on a referendum item in the form of a bond issue, whereby consensus or majority favor rules in the purchase/acquisition of land to be used for a specific purpose, such as open space. The Ames Quarry for example, which was described in Chapter 4 as a reality check on the demonstration model, required a consensus vote in order to purchase this 460-acre land area (Holland 2001):

> If 60 percent of voters [approved], the [City of Ames, Iowa] would borrow $4.97 million to purchase the land. The city has received a Vision Iowa grant of $1.5 million – contingent on the bond's approval – as well as a pledge of $1.03 million from the Story County Conservation Board to help with the purchase. The bond would raise property taxes $21 per $100,000 in property value every year for 12 years. Rental properties would increase $38 for every $100,000 in property value (Holland 2001, 3).

With the help from local media, open houses, and public speaking events politicizing the Quarry's benefits of restoring wetlands, filtering pollutants, providing recreation and a back-up water supply for the City, the bond issue gained voter approval and successfully passed.

In addition to incurring debt through a bond issue, there are a variety of techniques available to acquire and preserve open space, such as the following (Parks and Open Space Advisory Committee, 2002):

- Subdivision dedication - a developer dedicates land for parks or open space when the land is subdivided for development.
- Transfer of Development Rights - an owner transfers residential development rights from one agricultural property to another and receives a conservation easement in perpetuity.
- Full ownership by direct purchase - the most common method allows the full ownership of land for open space by direct purchase to be obtained.
- Purchase without Development Rights - the property is purchased but the owner retains the development rights for sale and transfer to another property later.
- Conservation Easements - the deed of conservation is acquired but the property is not owned.
- Bargain Sales - the owner sells the property at a value below market rate.
- Purchase Leaseback Agreements – it is agreed agricultural land shall be leased back to the seller for a specified time to continue farming.
- Donations - the owner donates the land or the conservation easement on the land and uses the value as a tax deduction.
- Intergovernmental Transfers - other governmental land is leased and managed, such as the Bureau of Land Management or the State Land Board.
- Joint City and County purchases - other cities are cooperatively worked with on open space preservation along city boundaries.

The above methods are some of the strategies that both private organizations and public municipalities may use as a means towards acquiring sustainable open spaces. A case study example that takes advantage of both public and private means in acquiring land for the establishment of a sustainable open space is the Prairie Green Preserve in the City of Geneva, Illinois.

The Prairie Green Preserve project involved the acquisition of agricultural land for the purpose of restoring the land back to its original state of prairie and wetlands. The project involved the purchase of private farmland at a per acre cost (Kunz 1999). The land to be acquired bordered on the City of St. Charles, Illinois, who entered into a consensus land-use plan agreement with the City of Geneva to share this property for recreational purposes (Kunz 1999). A consensus vote by Geneva residents passed a $10 million referendum in order to restore the project's 430-acres of land to pre-settlers' state (Kunz 1999). Shortly after this vote passed, the Illinois Department of Corrections, whose land bordered the Prairie Green Project as well, agreed to a land transfer, donating 340 acres to the project's cause (Kunz 1999). The Prairie Green Preserve, now a 770 acre project, more than doubled the amount of land Geneva residents were originally to receive for passing this referendum. The Prairie Green project, standing alone as <u>one</u> example of land acquisition, involved a combined variety of many of the Parks and Open Space Advisory Committee's techniques mentioned above. Techniques involving public and private means of acquiring open spaces are described in more detail below.

Public means of acquiring open space

The main public means of acquiring sustainable open space is through the use of zoning as regulation to control land. Zoning helps control the movement of the future direction and timing of urban growth. This type of movement in a community cannot be accurately measured by private land market actions and thus requires the involvement of a government entity to aid in land-use decisions and ensure that they are made from a regional perspective (Dawson 1982). The potential opportunity cost and loss of development compensation incurred by reserving land for uses such as sustainable open spaces is high.

Tax policies within municipalities may allow communities to generate revenues to afford the future acquisition of land for sustainable open spaces. Many local governments use taxation to effect low-density levels and to keep more open land open (Shomon 1971). "Through such measures as tax exemptions, tax deferments, preferential assessment, deferral, and differential rates, many municipalities are able to keep underdeveloped land open" (Shomon 1971, 86). Although the assessment of taxes can be used as a tool to acquire sustainable open space, much irrational use of urban land can be blamed upon the distributional power of governments to tax (Department of Housing and Urban Development 1965):

> No system of real property taxation, by itself, will assure the preservation of open space. Whether the land uses sought make sense from an urban planning point of view is of far less consequence to the local taxing jurisdiction than their relationship to the local tax structure. Tax policy can influence land use decisions, but only land use controls can assure that land will remain open. Its importance, therefore, is an adjunct to land use controls, a means of distributing the cost to the community of open space (Department of Housing and Urban Development 1965, 130).

Conservation easements are a main method providing an exemplary technique in which open spaces can be established for public purposes (Shomon 1971). The establishment of conservation easements to acquire land represents a common method used to maintain that a land stays "open" while leaving the fee title in private ownership. One of the benefits of conservation easements is that they are "tailored to suit the unique characteristics of individual properties as well as the different activities and interests of individual landowners" (Iowa Natural Heritage Foundation 1999, 7). Conservation easements permanently protect land by legally binding all present and future owners of the land. "Easements are recorded with the county recorder and are permanently attached to the title of the land thereafter, whether the land is transferred by sale, gift, inheritance, or bequest" (Iowa Natural Heritage Foundation 1999, 7). The sole responsibility of the recipient of an easement is to ensure that neither present nor subsequent owners disregard the regulations set forth in the easement (Iowa Natural Heritage Foundation 1999). In addition to conservation easements, other options to legally protect land may include mutual covenant, preserve dedication, and lease options (Iowa Natural Heritage Foundation 1999).

Few options are available when attempting to acquire sustainable open spaces using public means of acquisition. One element often not considered in a public land-use decision is whether or not it will pay its way. Cities often do not calculate these costs, not wanting that kind of black and white alternative (Myers 1981). "They would rather not lose the option of a political decision" (Myers 1981, 65). The private sector on the other hand must know what its land-use options cost before choosing. Private means of acquiring open space focus on additional available techniques that aid in the acquisition and preservation of open space.

Private means of acquiring open space

The preservation of sustainable open space is largely anchored through the efforts of private citizens and private organizations. These groups represent consensus at its best because they consist of individuals rallying together to dedicate and permanently preserve land for the enjoyment of generations to come. The participation of private landowners and civic organizations is necessary to help maintain a healthy balance between land for open space and land for other uses in communities (Shomon 1971). "Government land acquisition for open space uses has been unable to keep up with the demands of our expanding population and has been quick enough to save natural areas from destruction as a consequence of rapid economic growth" (Shomon 1971, 59). Many civic organizations have been successful in the establishment, funding, and preserving of open spaces. In fact, it is the donations, sales, or transfers of land from private landowners that allow many sustainable open spaces to be established and preserved.

Donations rely on the fact that the landowner is willing to protect their land at the cost of giving it away without direct financial compensation (Iowa Natural Heritage Foundation 1999). "A donation of land or interest in land is usually the simplest way to arrange outright transfers of title because no financing or negotiations about price are necessary" (Iowa Natural Heritage Foundation 1999, 15). Donating options of land for conservation uses such as sustainable open spaces include the following: donation of land for trade, donation by bequest, reserved life estate, donation of a partial interest, donation to establish a life income, and donating land as payment of inheritance tax (Iowa Natural Heritage Foundation 1999).

There are many advantages to donors apart from the creation of a legacy and ensuring the future of their land. For example, when land is donated for the purpose of a sustainable open space, existing advantages to the donor may include the following: they no longer pay real estate taxes; their income taxes are reduced; their estate is reduced in size causing estate taxes to diminish; and, if the recipient is a government agency or publicly supported, the donor has the possibility of being able to claim an income tax deduction of the market value of the land (Iowa Natural Heritage Foundation 1999).

In addition to land donations to aid in the establishment of sustainable open spaces, another attractive option to landowners may rest in the transfer of land covenant titles. In an effort to effect land use control through private means, transferring land covenant titles places limiting conditions on the use of land at the time it is transferred to another landowner (Iowa Natural Heritage Foundation 1999). Deed restriction, conditional transfer, and conservation easement prior to transfer are some of the techniques that allow a landowner to attach restrictive covenants to his/her land when transferring land for conservation use. The Iowa Natural Heritage Foundation (1999) explains why a landowner might consider this option:

> Whether the land is sold on the open market or sold or donated to a conservation agency, the landowner can attach conditions to influence its future use and protect its natural attributes. Conditions may not be needed if the receiving agency is likely to be long-lived and has proven faithful to its

> purposes. Also, the landowner may prefer not to restrict the agency's use of the land (Iowa Natural Heritage Foundation 1999, 29).

Moreover, transferring land covenant titles provides a landowner with additional assurance that his/her land will indeed be permanently preserved for use as a sustainable open space.

Overall, private means of acquiring open space provide options to landowners wishing to donate, sell, or transfer land. Tax advantages of donating, selling, or transferring land for the purpose of establishing sustainable open spaces are numerous. Incentives allow landowners to afford the preservation of land as sustainable open space for their own private enjoyment, public enjoyment, and most importantly, the enjoyment of future generations. Partnerships between private organizations and community landowners offer the means towards more achievable opportunities resulting in the permanent establishment of sustainable open spaces.

Summary

This chapter connects together sustainable open spaces with planning applications as related to the conceptual open space planning process. Communities are able to acquire land for establishing sustainable open spaces through both public and private means. Funding recommendations and written document language used to preserve and protect open space were discussed in this chapter. A community may use the application techniques suggested and included in this chapter as implementation strategies towards the establishment of a sustainable open space. Moreover, written language documentation tools (such as zoning and subdivision ordinance techniques), as well as the use of maps, may aid a community in implementing a sustainable open space.

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE STUDY

In Chapter 1, *General Introduction*, three propositions were described that defined the thesis study. The first proposition was that the creation of a conceptual open space planning process model, through its description and explanation of phases, would demonstrate methods and an efficient process for the preservation and/or implementation of sustainable open spaces. The second proposition was that the appropriate use of GIS as a planning tool within the conceptual open space planning process model, would prove to be a viable means to determine solutions and aid in decision-making about open spaces. The third proposition was that this analysis and demonstration of the open space planning process could be applied to the efficient establishment of sustainable open spaces in local communities. Through the thesis' structure and content, addressing of the propositions, and presentation of models, the results of this thesis acts as a planning resource reference for communities wishing to implement, preserve, and protect, sustainable open spaces.

This chapter includes analysis regarding the conceptual open space planning process model and the demonstration model, and the implementation and impact of sustainable open spaces in local communities in relation to the three sustainability principles/pillars. A discussion of recommendations for additional future research is also included.

Importance of Sustainable Open Spaces in the Urban Pattern

For the purpose of this thesis, "open space" was defined in Chapter 2, *Literature Review*, as environmentally sensitive natural land areas that provided enough area to allow for people and habitat to co-exist on an everyday basis. Moreover, an "open space" was defined as an area that contains or serves the function of environmentally sensitive land, and provides social, recreational aspects for the enjoyment of local citizen populations.

Sustainability, in practice and in method, offers a model to manage land-use change and/or the incorporation of an open space within a community. This model was shown in the form of a three-legged stool (see Figure 1, page 14) and relied on the "pillars" of economic values, environmental values, and social values to keep it standing upright and function effectively. "Sustainable" open spaces connect together environmentally sensitive areas and sprawling communities using landscape ecology principles. Discussed limitations of the demonstration model in Chapter Four reinforced the importance of landscape ecology principles as part of the conceptual open space planning process model in determining sustainable open space areas.

Analysis of Conceptual and Demonstration Models

Chapter 3, *Methods,* reviewed and reflected on various planning process models as a consortium to prepare and create for a conceptual open space planning process model. "Planning process theories provide important but incomplete procedural models for carrying out planning efforts" (Kaiser, Godschalk, and Chapin, Jr. 1995, 37). While an adequate conceptual open space planning process model was created and its stages clarified, the model theoretically stood alone. The demonstration model as presented in Chapter 4, *Results*, illustrated a hypothetical situation based upon the conceptual planning process open space model. Concepts and recommendations elaborated on in Chapter 5, *Implementation,* provided suggested techniques as a reference to follow after the methods application of the demonstration model. These suggested techniques provided direction regarding how a sustainable open space may be effectively implemented within a community.

Sustainable Open Space Implementation in Communities

Consensus building in a community plays an important role in the planning process and the implementation of a sustainable open space. The implementation of an open space involves the cooperation and collaboration of decision-makers, planners and/or intergovernmental staff, and the public; the case studies of Ames Quarry and the Prairie Green Preserve project, as alluded to in Chapter Five, make reference to this by conveying real-world examples. Consensus building in a community relies on a collaboration of citizen participants in decision-making. Consensus based decision-making for this thesis was included in every phase of the conceptual open space planning process model. Decision-making steps in this model allowed for natural resource factor selection as input, and GIS as a means to determine solutions.

GIS is a computer-based tool for mapping and analyzing things that exist and events that happen on Earth (Anderson 2002). GIS technology supports decision-making and allows local governments to integrate management and planning with community values. Use of a GIS system promotes and enhances efficiency of a local government or community through its analysis and display capabilities. Moreover, maps produced using a GIS, allow planners, intergovernmental staff, and citizens to better chart a course of development that "meets local needs and interests, but is implemented in light of a thorough understanding of [various] forces" (O'Looney 2000).

Communities that use GIS as a planning tool and means to determine solutions in decision-making are able to examine the larger community image effecting social values, markets effecting economic values, and land-use plans effecting environmental values. GIS, as used for the identification of sustainable open spaces, produces an efficient byproduct (O'Looney 2000):

> Local governments use GIS technology to support open space planning, identifying key parcels that need to be purchased for parkland or otherwise protected from development. By combining parcel map [themes] with [themes] showing land use, transportation and utility arterials, growth patterns, and zoning, planners can identify land that has high value as green space, that will likely be available for purchase, that is within an identified greenbelt area, or that is most likely to provide the greatest amount of green space for the available resources (O'Looney 2000, 135).

The decisions for which land parcels are to be acquired for open space development are more often the result of political machinations than that of a rational, orderly process. The planning process portrayed in the conceptual open space model incorporates community objectives and citizen participation that may efficiently allow a community to make decisions more rationally. The demonstration model in this thesis used GIS as a means to determine solutions for the site location of sustainable open spaces and the preservation of environmentally sensitive areas in local communities. Conclusions formed around the analysis of using GIS as a tool to aid in the implementation of sustainable open spaces provided for an exemplary process towards the practice of establishing sustainable open spaces in the urban pattern.

Open space implementation and environmental impacts

As discussed in Chapter 2, *Literature Review*, sustainable open spaces that are connected, adjacent to, or are surrounding environmentally sensitive areas provide a key amenity resource within a community; they allow people to co-exist with nature without displacing nature and its habitat, thus allowing people to live and develop while avoiding harm to natural processes.

The implementation of a sustainable open space within a community allows land containing natural resources and/or environmentally sensitive lands to be set-aside for future generations to enjoy. Environmental impacts, such as the enjoyment of environmental land areas, lead to social impacts that seemingly affect resident's local quality of life. Environmental impacts may positively affect economic impacts as well, by fiscally lessening a community's water quality costs. Economic impacts in this category may also involve recreational and aesthetic opportunity costs gained from the preservation and protection of natural resource amenities in open space land-use developments.

Open space implementation and social impacts

Sustainable open spaces implemented in communities bestow citizens with public areas to congregate and interact. Socially, open spaces provide for recreational needs, and allow for mental and physical human release from dense areas (thus aiding in the development of healthy personalities), as well as providing for naturally attractive areas within a community.

In addition, social interactions and consensus involvement on behalf of citizen participants for the cause of establishing a sustainable open space within their local communities may initially increase local civic boosterism. A community that lives together ought to plan together; sustainable open spaces are to be enjoyed by and made accessible to all residents of a community. The implementation of an open space, as alluded to in the conceptual open space planning process, requires an agreed upon collaboration on an assortment of details from factor selection to project follow-up.

Open space implementation and economic/fiscal impacts

A community must plan fiscally for the establishment of a sustainable open space. It is necessary for citizen participants to cooperate with planners and/or governmental staff when planning and budgeting for an open space. A common scenario is for a consensus vote on behalf of citizen participants to lead to additional funding received through publicly available grants and bond monies. Such a scenario requires public and private involvement in order to achieve a successful acquisition of land for the purpose of establishing a sustainable open space. The purpose of acquiring or implementing a sustainable open space may not initially be a financial decision, yet acquisition of land for the purpose of establishing one nearly always proves susceptible to financial justification in the end.

Communities that invest in the establishment of sustainable open spaces are proven to economically save money in the long run; meanwhile, the sustainable open space provides a community with a unique series of benefits such as those found under the environmental value and social value categories. These areas, when developed as aesthetically pleasing recreational destinations, have the ability to attract out-of-town visitors and their money into a community. Moreover, sustainable open spaces, through the preservation of environmentally sensitive areas, have the ability to generate revenue for a community.

Recommendations for Additional Research

Future needs related to this study ought to place emphasis on a technique to efficiently conduct a needs assessment in order to gather and collect data regarding citizens' land-use desires in a community. This needs assessment should be linked to the demonstration model and its use of GIS. Possibly, a web-based survey could be conducted with citizens' answers serving as criteria as input into the model and immediately producing on-line mapped results. A needs assessment, as accessed through these means and in this way, would produce a more representative citizen consensus regarding how to appropriately weight factors. Although not everyone may own or have access to a computer, a local library might be able to possibly aid in the survey, or a community could set up multiple kiosks for a few days in order to gather information. It would create for a more interesting study to analyze the demonstration model in real-time rather than as a hypothetical situation, and measure citizens' responses and the differing mapped scenarios they might produce based upon this method. This type of research would require knowledge of script-writing, and plenty of time doing so, in order to produce a result which would allow an adequate amount of time for measurements. Using a web-based survey to produce immediate results may aid in solving one of the aforementioned limitations of the demonstration model, in terms of decreasing human error.

In terms of the demonstration model and its use of a weighting and rating technique, it may be beneficial to investigate other criteria measurement methods. Hobbs (1985 & 1994) writes about alternative measurement methods in his quoted sources. In his articles, Hobbs (1985 & 1994) elaborates on a need for validity and results when assigning weight assessment to multiple criteria. Criteria weight assignment in a GIS model is important to a community and their decision-making for the main reason that when one criteria factor is rated high, another factor must be "traded off" and thus ranked lower (Hobbs 1994). Citizen participants, planners, and intergovernmental staff using a GIS system and model (such as the demonstration model) to determine land-use allocation ought to have a clear understanding of their quantitative rankings by weight in order to obtain desired qualitative results. Although alternative measurement techniques were not elaborated on in this thesis, an investigation into these other methods as a future topic of research would be beneficial. More importantly, this type of investigation might also allow decision-makers more scenarios to choose from when implementing a sustainable open space (based upon various trade-offs).

Additional research should also focus more on the connectivity of the principles of sustainability and landscape ecology. Land linkages of environmentally sensitive areas in sprawling communities allow for increased species and habitat survival. Communities are already being encouraged to establish open spaces that physically link to already existing open spaces through the ecological means of corridors and buffers. It would be helpful to develop a mapping process using a GIS model that would make connectivity in a community more accessible and visual, although this would most likely require analysis existing outside of ModelBuilder's capabilities.

In general, recommended future study regarding sustainable open spaces ought to place more emphasis on equity, access, and policy-making in terms of planning and locating a site. "Equity is a subjective perception that things are just and fair" (Wolfe 1999). Equity is not synonymous with equality, but rather emphasizes that the distribution of wealth, opportunity, and power is seen to be fair (Wolfe 1999). What is considered to be equitable is very much based on individual values and ethics (Wolfe 1999). Getting back to the "tragedy of the commons," an equitable view of community means ensuring that natural and environmental resources are being used fairly for all people. An analysis involving the most equitable establishment of a sustainable open space within local communities will require more research into the applications of implementation and in relation to the decision-making phase (PHASE III) of the conceptual open space planning process model.

REFERENCES CITED

Alexander, Ernest R. 1992. *Approaches to planning* (2nd ed.). Luxembourg: Gordon and Breach Science Publishers SA.

American Planning Association (APA). 2002, April. Policy guide on smart growth [online]. Available at http://www.planning.org/policyguides/smartgrowth.htm. Accessed October 1, 2002.

Anderson, Paul. 2002. *Personal communication.* Iowa State University Professor of Landscape Architecture, Ames, Iowa. December 3, 2002.

Arendt, Randall. 1999. *Growing greener.* Washington D.C.: Island Press.

Arendt, Randall. 1992, July/August. Open space zoning: what it is and why it works. *Planning Commissioners Journal* 5: 4.

Baylor, Stephen. 1975. *The garden city.* Milton Keynes: The Open University Press.

Benhart, J.E. and W. Welsh. 1992, January-February. The Interstate 81 Corridor and South-Central Pennsylvania: land-use in nonmetropolitan America. *Small Town,* pp. 12 - 18.

Bradbury, Susan. 2001. *Lecture.* Land-Use Planning (CRP 521), Iowa State University, Department of Community and Regional Planning, Iowa. August 30, 2001.

Brenneman, Russell L. 1967. *Private approaches to the preservation of open land.* New London: Conservation and Research Foundation.

Chic 2 Consortium. 1998-1999. Engineering of optimisation projects [online]. Available at http://www-icparc.doc.ic.ac.uk/chic2/chic2_methodology/index.html. Accessed January 13, 2003.

City of Ames, Iowa. 1996-2002. Ames park system [online]. Available at http://www.ames.ia.us/. Accessed January 15, 2003.

City of Ames, Iowa. 2002. ArcView GIS city zoning data [online]. Available at http://www.city.ames.ia.us. Accessed May 20, 2002.

COBERI (City of Bloomington Environmental Resource Inventory). 2002. Categories for COBERI project. Bloomington, IN. Available at http://www.city.bloomington.in.us/planning/env/coberi/categories.html#soils. Accessed February 20, 2003.

Daniels, Thomas L., John W. Keller, and Mark B. Lapping 1995. *The small town planning handbook* (3rd ed.). American Planning Association (APA) Planning Press.

Dawson, Alexandra D. 1982. *Land-use planning and the law*. New York, N.Y.: Garland STPM Press.

Department of Housing and Urban Development. 1965. *Open space for urban America*. Washington D.C.: U.S. Government Printing Office.

Devuyst, Dimitri, ed. 2001. *How green is the city?: sustainability assessment and the management of urban environments*. New York: Columbia University Press.

Environmental Systems Research Institute, Inc., 1998, July. Basic GIS [online]. Available at http://www.esri.com. Accessed May 21, 2002.

Environmental Systems Research Institute, Inc., 2002a. GIS basics: quick intro to GIS, ArcView GIS, and ArcInfo [online]. Available at http://www.esri.com/industries/k-12/basicgis.html. Accessed May 21, 2002.

Environmental Systems Research Institute, Inc., 2002b. ModelBuilder [online]. Available at http://www.esri.com/software/arcview/extensions/modelbuilder-new.html. Accessed February 20, 2003.

Farina, Almo. 2000. *Landscape ecology in action*. Dordrecht; Boston: Kluwer Academic.

Federal Geographic Data Committee. 2003. Geospatial metadata [online]. Available at http://www.sdvc.uwyo.edu/metadata/why.html. Accessed February 20, 2003.

Fodor, Eben. 1999. *Better not bigger*. Gabriola Island, B.C.: New Society Publishers.

Foote, Kenneth E. and Donald J. Huebner. 2000, June. The geographer's craft project [online]. Austin, TX: Department of Geography, University of Texas at Austin. Available at http://www.icls.harvard.edu/gis/images/vectrast.html. Accessed November 20, 2002.

Gillham, Oliver. 2002. *The limitless city*. Washington D.C.: Island Press.

Gouldson, Andrew, and Peter Roberts, eds. 2000. *Integrating environment and economy*. London: Routledge.

Haines-Young, Roy, David R. Green, and Stephen R. Cousins, eds. 1993. *Landscape ecology and GIS*. London: Taylor & Francis Ltd.

Hardin, Garrett. 1968. The tragedy of the commons. *Science* 162: 1243-1248.

Hobbs, Benjamin F. December 1985. Choosing how to choose: comparing amalgamation methods for environmental impact assessment. *Environmental Impact Assessment Review* 5 (4): 301-319.

Hobbs, Benjamin F., and Peter M. Meier. November 1994. Multicriteria methods for resource planning: an experimental comparison. *IEEE Trans. on Power Systems* 9 (4): 1811-1817.

Hoch, Charles J., Linda C. Dalton, and Frank S. So, eds. 2000. *The practice of local government planning* (3rd ed.). Washington, D.C.: International City/County Management Association (ICMA).

Holland, Anna. 2001. Residents to vote on Hallett's Quarry. In *Iowa State Daily*. November 5, 2001.

Honadle, G. 1985. *Implementation for sustainability*. Ann Arbor: UMI Books on Demand.

Innes, Judith E. 1996, Autumn. Planning through consensus building: a new view of the comprehensive planning ideal. *Journal of the American Planning Association* 62 (4): 460 - 472.

Iowa City, City Council. 1995, November 7. Agenda, regular council meeting [online]. Iowa City, Iowa. Available at http://www.iowa-city.org/agenda/1995_agendas/11-07-95.htm. Accessed February 20, 2003.

Iowa Department of Natural Resources, Natural Resources Geographic Information System. 2002. ArcView GIS data [online]. Available at http://www.dnr.state.il/orep/nrrc/gis.htm. Accessed May 21, 2002.

Iowa Gap Analysis Program. 2002. ArcView GIS landcover data [online]. Available at http://www.ag.iastate.edu/centers/cfwru/iowagap/. Accessed May 20, 2002.

Iowa Natural Heritage Foundation (INHF). 1999. *The landowners options* (5th ed.). Des Moines: Iowa Natural Heritage Foundation.

Janzen, Daniel. 1998, February. Gardenification of wildland nature and the human footprint. *Science* 279: 1312-1313.

Kaiser, Edward J., David R. Godschalk, and F. Stuart Chapin, Jr. 1995. *Urban land use planning* (4th ed.). Urbana and Chicago: University of Illinois Press.

Kay, Jane Holtz. 2001, January. Closing down 'open space'. *Landscape Architecture*, pp. 119 -120.

Kelly, Eric Damian and Barbara Becker. 2000. *Community planning*. Washington, D.C.: Island Press.

Kunz, Tona. 1999. DOC's land donation could open up space at Prairie Green. In *Kane County Chronicle*. September 24, 1999.

Labaree, Jonathan M. 1992. *How greenways work: a handbook on ecology*. Ipswich: National Park Service and Atlantic Center for the Environment.

Land Information and Computer Graphics Facility. 2002. Shaping Dane project website [online]. School of Natural Resources, College of Agriculture and Life Sciences, University of Wisconsin-Madison. Available at http://www.lic.wisc.edu/shapingdane/. Accessed May 15, 2002.

Lucht, James and Lorraine Joubert. 2002. Rapid Site Assessment guide [online]. Available at http://www.uri.edu/ce/wq/mtp/rapid/default.htm. Accessed October 28, 2002.

McAllister, Donald M. 1973. *Environment: a new focus for land-use*. Washington, RANN (Research Applied to National Needs, National Science Foundation).

McHarg, Ian L. 1992. *Design with nature*. Garden City: John Wiley & Sons, Inc.

Mattson, Gary A. 2002. *Small towns, sprawl and the politics of policy choices*. Lanham, MD: University Press of America.

Monmonier, Mark. 1996. *How to lie with maps* (2nd ed.). Chicago and London: The University of Chicago Press.

Moore, Terry. 1978, October. Why allow planners to do what they do? a justification from economic theory. *Journal of the American Institute of Planners*, pp. 387 - 398.

Myers, Marilyn. 1981, June. Economic, planning and political processes altering urban open space: selected references with a case study. *Council of Planning Librarians (CPL) Bibliography* 56: 65-72. Chicago: CPL Bibliographies.

Norris, William D. and Donald R. Farrar. 1999. A municipal inventory and evaluation of natural areas: history and methodology. *Journal of the Iowa Academy of Science* 106 (3): 49 - 62.

Oklahoma Center for Geospatial Information. 2003. Metadata? [online]. Stillwater, Oklahoma. Available at http://www.seic.okstate.edu/gis/metadata.html. Accessed February 20, 2003.

O'Looney, John. 2000. *Beyond maps: GIS and decision making in local government*. Redlands, CA: ESRI.

Parks and Open Space Advisory Committee. 2002. Open space acquisitions [online]. Boulder County, Colorado. Available at http://www.co.boulder.co.us/openspace/au_acquisitions.htm#Funding%20Sources. Accessed May 20, 2002.

Peck, Sheila. 1998. Planning for biodiversity. Washington, D.C.: Island Press.

Prior, J.C. 1991. Landforms of Iowa. Iowa City, IA: University of Iowa Press.

Rhind, DW. 1990. Global databases and geographic information systems. In *The Association for Geographic Information Yearbook* 1990, edited by M.J. Foster & P.J. Shand, 218-223. London: Taylor & Francis and Miles Arnold.

Rich, Richard C. 1977, December. Government structure and the future of urban planning and administration. *SRPA*, pp. 333 – 349.

Schoon, B.R. 1991. *Using the Land Evaluation and Site Assessment (LESA) technique in the rural-urban fringe: A case study of Dallas County, Iowa.* M.S. thesis, Iowa State University, Ames, Iowa.

Seamon, David, ed. 1993. *Dwelling, seeing, and designing: toward a phenomenological ecology.* Albany: State University of New York Press.

Shomon, Joseph James. 1971. *Open land for urban America.* Baltimore: Johns Hopkins Press.

Steiner, Frederick. 1994. The living landscape: an ecological approach to landscape planning. In *Futures by design: the practice of ecological planning*, edited by Doug Aberley, 161 - 191. Philadelphia: New Society Publishers.

Stone, Dan, and Geary M. Schindel. 2002, April. The application of GIS in support of land acquisition for the protection of sensitive groundwater recharge properties in the Edwards Aquifer of south-central Texas. *Journal of Cave and Karst Studies* 64(1): 38-44.

Story County, Iowa. 2002. About Story County, Iowa [online]. Available at http://www.storycounty.com/. Accessed November 5, 2002.

Thayer, Robert L. 1994. *Gray world, green heart.* New York: Wiley.

Thorne, James F. 1993. Landscape ecology: a foundation for greenway design. In *Ecology of greenways: design and function of linear conservation areas*, edited by Smith, Daniel S. and Paul Cawood Hellmund. Minneapolis: University of Minnesota Press.

Thrall, Grant Ian, Bert Swanson and D. Nozzi. 1998. Greenspace Acquisition and Ranking Program (GARP): a computer assisted decision strategy. *Computers, environment, and urban systems* 12, pp. 161- 184.

Trust for Public Land. 2001, March. Prioritizing property [online]. Available at http://www.tpl.org/tier3_print.cfm?folder_id=1185&content_item_id=3462&mod_type=1. Accessed May 17, 2002.

U.S. Department of the Interior and U.S. Geological Society. 1992. Geographic Information Systems. *Informational packet/brochure.*

Wilson, William H. 1989. *The city beautiful movement.* Baltimore: Johns Hopkins Press.

Wolfe, Joshua. 1999. "The ABC's of sustainable communities: a work in progress" [online]. Paper presented at the 1999 APA National Planning Conference, City of Seattle, WA. Available at http://www.asu.edu/caed/proceedings99/WOLFE/WOLFE.HTM#INFO. Accessed April 6, 2003.

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APPENDIX A: DEMONSTRATION MODEL DATA INPUT

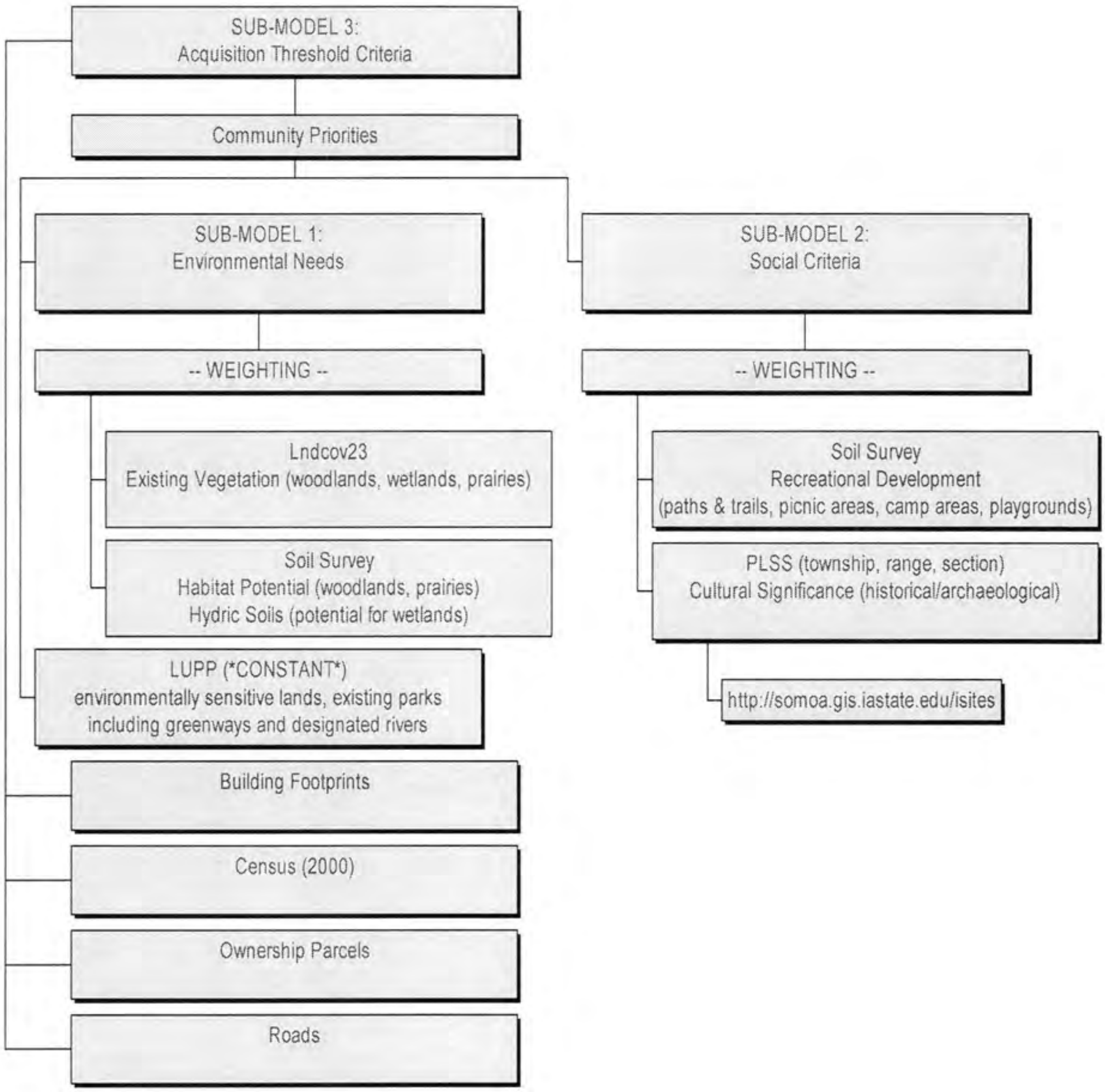

Figure 20. GIS Data Input into Demonstration Model

Sub-Model 1:

Environmental Needs -

- Lndcov23 (Source: Iowa Gap Analysis Program; GAP data – to determine existing woodlands, wetlands, and prairies)
- Soil Survey (Source: IDNR Natural Resources Geographic Information System; to determine habitat suitability potential for woodlands and prairie)
- Potential for wetlands (derived from hydric soils data)
- Land-Use Policy Plan (Source: City of Ames, IA; Land Use Policy Plan (LUPP) - to determine environmentally sensitive areas which includes greenways and designated rivers)

Sub-Model 2:

Social Criteria -

- Soil Survey (Source: IDNR Natural Resources Geographic Information System; to determine recreational development suitability)
- Sites of cultural significance (historical/archaeological) – using PLSS data

CONSTANT: Environmentally Sensitive Areas (Source: City of Ames, IA; LUPP)

Sub-Model 3 (for a mapped visual reference displaying selected site solutions):

Acquisition Threshold Criteria -

- Assessor's data (Source: City of Ames, IA; to depict cost and ownership of parcel)
- Land Use Policy Plan (Source: City of Ames, IA)
- Zoning (Source: City of Ames, IA), Projected/Existing Population (to depict need for open space and equal access to areas on a 1 acre to 1,000 individual scale)
- Existing Parks (Source: City of Ames, IA; LUPP)
- Roads (Source: IDNR Natural Resources Geographic Information System; for locational/visual purposes)
- Building Footprints (to determine if the land is already developed)

APPENDIX B: COBERI (2002) ENVIRONMENTAL RESOURCE FACTORS

SOILS

The locations and types of soils are an important consideration for conservationists and planners. Soils rated as prime or of statewide significance by local or county conservation districts are resources that must be conserved and used cautiously. In order to effectively manage and plan land use activities, it is essential to determine soil related hazards and characteristics such as.

- soil stability;
- soil permeability;
- soil type;
- soil content;
- compaction rates; and
- infiltration rates.

Soil related hazards and limitations are also useful in deciphering specific types of mass wasting process that may occur in an area. This information is very useful for implementing mitigation measures in the design and construction phases of different types of developments and land use activities.

WETLANDS

Wetlands provide unique conditions and habitats that are important to an ecosystem's health. Wetlands play a very important role in an ecosystem including:

- improving water quality through bio-filtration;
- supplying a source for surface water and groundwater recharge;
- providing a sink for surface runoff to control erosion and flood hazards;
- offering habitat for a diversity of wildlife and vegetation; and
- presenting the community with excellent educational opportunities.

Wetlands are defined by three characteristics. They are:

1. Sustained soil saturation or recurrent saturation at or near the soil's surface;
2. Soil type is classified as hydric; and
3. Vegetation is water tolerant (hydrophytes).

It is essential to locate wetlands and to provide adequate buffer zones to preserve and enhance their integrity. In order to implement sustainable development strategies, sound planning and management practices must include the preservation and enhancement of these natural features.

FLOODPLAINS AND WATERWAYS

Floodplains and waterways are essential components of an ecosystem. Some of the main functions of flood plains and waterways are:

- acting as flood control regulators;
- providing vegetative filters for runoff;
- supplying communities with potable water; and
- offering habitat for a diversity of wildlife and vegetation.

It is important to locate natural surface and subsurface waterways, as well as their surrounding floodplains in an effort to better understand and protect them. Surface water systems circulate and distribute water naturally into lakes, rivers, streams, creeks and wetlands by means of waterways. The areas adjacent to each waterway are extremely susceptible to inundation by flooding during storms and are called floodplains.

Typically, floodplains are delineated by land that is underwater at least once during any calculated 100-year storm. Both floodplains and waterways are contained by an area called a watershed.

Watersheds are defined naturally by the topography of the land and encompass the entire area that drains to a particular waterway system. During the planning process it is important to identify floodplains, waterways and watersheds in an effort to protect and maintain them at a sustainable level.

BROWNFIELDS

Brownfields are abandoned, idled, or under utilized industrial or commercial properties where expansion or redevelopment of the site may be complicated by real, or perceived environmental contamination. This category may include:

- abandoned commercial and industrial sites with potential remediation and/or re-use such as locomotive switchyards and industrial plants;
- under utilized or inappropriately used commercial and industrial sites with potential remediation and/or re-use such as salvage yards and abandoned gas stations; and
- prolonged vacant or idled commercial buildings or sites within a downtown district that are suspect of contamination such as dry cleaners and garages.

The redevelopment of brownfield sites is beneficial to the community and the environment in the following ways:

- helps to preserve green areas and discourages urban sprawl outside of municipal boundaries;

- cleans up idled, contaminated sites;
- recycles and reuses pre-existing structures and services often improving the appearance of the surrounding community;
- re-creates jobs; and
- returns vacant land back to the tax base to help further services to increase neighborhood economic vitality.

It is important to identify the location of brownfields in the planning process in order to effectively plan long-range activities such as redevelopment and rezoning, as well as implementing site remediation programs.

PARKS AND PATHWAYS

Federal, state and locally designated parklands and pathways are of great importance to a community. This category includes:

- federal, state, county and city owned parks, nature preserves and conservation areas;
- neighborhood pocket parks;
- multi-use pedestrian pathways, trails, greenways and easements; and
- other important recreational areas.

It is important to be sensitive to the locations of each of the above resources in order to effectively plan for tourism and recreational development. Parks and pathways may be used for the creation and preservation of buffer zones, corridors, and future greenways.

CONTAMINATED LAND

It is essential to identify land of environmental concern in order to plan in an equitable and just manner, as well as to protect public safety. Contaminated land includes the following:

- known sources of excess water pollution;
- known sources of excess air pollution;
- known sources of excess land pollution;
- hazardous/nuclear waste facilities;
- Superfund sites;
- solid waste facilities and landfills;
- nuclear facilities;
- incinerators; and

- land constrained by known contamination.

Determining the location of contaminated, and potentially contaminated land is very important in order to practice sound long-range planning. Prior to designating zoning and land use activities, potential hazards and risks to human health and the environment must be considered. Contaminated land may also dictate surrounding land uses such as industrial, business parks, commercial and open space depending on the state of the surrounding environment.

TOPOGRAPHY

In achieving conservation objectives it is helpful to identify the different categories of slopes within a particular area. The relief of the landscape is important because it dictates the potential for erosion and mass wasting, as well as special planning and design provision that must be used.

The topography of an area may also dictate whether that particular area is developable or not depending on the flatness or hilliness of the landscape. During construction it is important to minimize all slope disturbing activities and use the existing topography for development plans.

Typically, slopes over 12% are considered to be steep and require special attention. During construction, special slope protection techniques such as geo-textile matting, strawing and riprap may be used to limit erosion and siltation of downslope waterways. The construction and design of developments on steep slopes may include walk out basements, exposed lower levels and other slope mitigating features to limit slope disturbance. Slopes over 25%, as well as ridges and valleys should be avoided.

WILDLIFE HABITAT

If native biodiversity is to be maintained and enhanced, sensitive areas where wildlife and vegetation live need to be properly protected and managed. It is important to locate these areas in an effort to create buffers and corridors, as well as implement conservation plans to preserve these resources. Wildlife habitats include:

- important breeding grounds;
- nesting grounds; and
- areas that rare or endangered species require.

Locating these areas is an essential part of helping planners and conservationists implement plans that respect and enhance the environment. It is important to consider the use of land surrounding sensitive habitats. Uses that may have negative impacts on sensitive habitats include some heavy industrial, institutional, commercial and high-density residential uses. Surrounding land uses that may be more compatible with the sensitive habitat include parks, greenways, nature preserves or openspace.

VEGETATIVE COVER

During the planning process, it is important to locate and identify the different types of vegetative cover. In this study vegetative cover includes both native grasslands such as pastures and seedlings, and tree coverage such as forests and native tree stands. Native plant communities provide a variety of ecological benefits including:

- protection of water resources;
- natural slope protection;
- maintaining biodiversity by offering wildlife habitat;
- maintaining biodiversity of native vegetation;
- providing a carbon sink and source of oxygen; and
- providing educational opportunities.

It is important to preserve native vegetative cover to preserve biodiversity and provide both rural and urban greenspace. The preservation of vegetation provides not only a sanctuary for wildlife and avoids the further fragmentation and loss of biodiversity, but also provides openspace for greenways and parks.

CONSERVATION LAND

Conservation land includes areas specifically set aside during the development process for conservation easements or tree preservation easements. This category also includes any land acquired by private land trusts.

Conservation land provides intermittent sanctuaries for wildlife, shade from the sun, filters pollutants, absorbs rainfall and slows runoff velocities coming from surrounding developments. The location of conservation land must be considered in planning and managing any area. This is an important consideration not only to ensure that surrounding land uses are compatible, but also to ensure future compliance for parcels set aside as conservancies.

CULTURAL RESOURCES

It is important to identify the location of cultural resources such as buildings and other resources with historic, archeological or cultural significance. In order to effectively preserve and enhance these resources, sound planning and management principles must be applied. In this study, cultural resources include:

- historic buildings (local, state and federal);
- historic properties and landmarks (local, state and federal);
- monuments, statues and significant works or art;
- archeological sites including ruins, burial grounds and cemeteries; and

- sites of cultural significance such as quarries and farmsteads.

Cultural resources are important educational, recreational and social resources of any community. It is essential to determine the location of significant cultural resources to effectively create, and implement long-range planning and management policies. During the planning process, cultural resources are considered in determining the potential future use, development, and design of the immediate and surrounding areas.